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DEPARTMENT OF THE NAVY
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HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

ACTION MEMORANDUM AND FINAL ENGINEERING EVALUTION/COST ANALYSIS SITE IR-03 REMOVAL ACTIONS WASTE OIL RECLAMATION PONDS

FINAL

October 18, 1996

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Encl: (1) Final Action Memorandum for the Removal Action Documentation for Site IR 3, Waste Oil Reclamation Ponds, Engineering Field Activity, West, Naval Facilities Engineering Command, San Francisco, California, dated 18 Oct 1996

1. Enclosure (1) is forwarded in accordance with the Hunters Point Annex Federal Facilities Agreement. The Final Engineering Evaluation/Cost Analysis for Site IR 3, dated 18 October 1996, is included in Attachment A to enclosure (1), within which is the Navy's response to Agency comments on the Draft Action Memorandum. In Attachment C of enclosure (1) is the responsiveness summary, which includes responses to public comments on the Draft Action Memorandum.

2. If you have any questions regarding these enclosures, please contact Ms. Luann Tetirick at (415) 244-2561, FAX (415) 244-2654.

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By direction of
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Attachment

Attachment	
A	Final Engineering Evaluation and Cost Analysis, Site IR-03 Removal Actions, Waste Oil Reclamation Ponds
B	Site IR-03 Removal Action Administrative Record Index
C	Responsiveness Summary

1.0 PURPOSE

The purpose of this action memorandum is to request and document approval of a non-time-critical removal action at Site IR-03 Waste Oil Reclamation Ponds at Hunters Point Shipyard (HPS) in San Francisco, California. As the lead agency, the Department of the Navy ("Navy") has authority over the selection of the removal action alternative, the risk evaluation, and overall public participation activities. The Navy is working in cooperation with the U.S. Environmental Protection Agency (EPA) Region IX; the State of California Department of Toxic Substances Control (DTSC) Region II; and the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB) to develop and implement the removal action.

This action memorandum has eight sections including this one. Section 2.0 discusses site conditions and background information for HPS; Section 3.0 discusses threats to public health and welfare and to the environment from the waste oil reclamation ponds; Section 4.0 presents the endangerment determination; Section 5.0 discusses the proposed removal action and estimated cost; Section 6.0 discusses the effects should the removal action be delayed or not taken; Section 7.0 discusses outstanding policy issues; and Section 8.0 discusses the recommended removal action alternative. Attachment A presents the final engineering evaluation and cost analysis (EE/CA) report dated October 18, 1996, including figures, tables, and cost estimates, and Attachment B presents the administrative record index for this action.

2.0 SITE CONDITIONS AND BACKGROUND

This section discusses (1) the site description, (2) other actions conducted to date at HPS, and (3) the state and local agencies' roles.

2.1 SITE DESCRIPTION

This section discusses the removal site evaluation, the physical location of HPS, Site IR-03 characteristics, release information, the National Priorities List (NPL) status of HPS, and Site IR-03 figures.

2.1.1 Removal Site Evaluation

Site IR-03 ("the Site") is the location of two Navy-operated former waste oil reclamation ponds which were in use from 1944 until 1974 at HPS. The Site is located in Parcel E, along the southeastern shoreline of HPS, and is completely surrounded by IR-02 (Attachment A, Figures 1-1 and 1-2). The unlined ponds were constructed from fill material and located approximately 30 feet from the San Francisco Bay shoreline. An Initial Assessment Study (IAS) estimated that approximately 0.6 to 2.0 million gallons of oily wastes were received annually at the reclamation ponds. Reclaimed oil was removed periodically by a private contractor who sold much of it for road oil. Recent sampling events have confirmed the presence of hazardous substances and oily waste including free-phase petroleum products near the former waste oil ponds from existing surface levels to approximately 25 feet below ground surface (bgs). Hazardous substances (including metals, semivolatile organic compounds [SVOCs], and volatile organic compounds [VOCs]) appear to be commingled with, or constituents of, the oily waste.

Samples contained hazardous substances as defined by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), including metals, SVOCs, and polychlorinated biphenyls (PCB), at concentrations exceeding screening levels. Due to the close proximity of the ponds to San Francisco Bay and the results of the site investigation, the primary concern is the potential migration of contaminants in groundwater to the Bay. The EE/CA report, which is Attachment A of this action memorandum, presents site-specific information for IR-03.

2.1.2 HPS Physical Location

HPS is in southeastern San Francisco at the tip of a peninsula extending into San Francisco Bay (see Figure 1-1 of Attachment A). HPS encompasses 936 acres, 493 of which are on land and 443 of which are below the waters of the bay. HPS has been divided into five parcels of land, Parcels A through E, and Parcel F, which includes the subtidal areas. Site IR-03 is located near the shoreline in the southeastern portion of Parcel E (Figure 1-2 of Attachment A).

HPS is bordered by San Francisco Bay to the north, east, and south. A mixed-use residential and industrial area is located west of HPS. The northern and eastern shores of HPS were developed for ship repair and are equipped with drydock and berthing facilities. The Navy used HPS from 1939 through 1976 for ship repair. Triple A Machine Shop ("Triple A") operated HPS as a commercial ship repair facility from 1976 to 1987. Currently, the Navy and private businesses use HPS for limited commercial and light industrial activities.

2.1.3 IR-03 Site Characteristics

This section summarizes the nature and extent of chemicals found in soil and groundwater at the Site. The information is based on previous investigations that have been conducted in the IR-02 and IR-03 areas over the past decade. Hazardous substances and petroleum products are present in the vicinity of the former waste oil ponds, including floating product. The ponds have been covered with fill material which eliminates any visible surface expression of floating product or oily waste. This removal action will use the visibility of both floating product and product-affected soils as the indicators for the extent of hazardous substances.

2.1.3.1 PREVIOUS INVESTIGATIONS

For the past ten years, an ongoing series of assessments has been conducted to investigate the former waste oil reclamation ponds. The main investigations in chronological order are as follows:

- An Initial Assessment Study (WESTEC 1984) was completed in 1984 that focused on the history and work practices at the HPS.
- Soil and groundwater sampling were first completed in 1986 when five borings were drilled and sampled (EMCON 1987). Wells IR-03MW0-1 through -0-3 were installed in three of these borings.
- A series of site investigations commenced in 1989 with reconnaissance and preliminary phase investigations conducted as part of the OU-1 RI by Harding Lawson Associates (HLA) in 1993. These investigations included geophysical and soil gas surveys, boring and test pit installation and testing, and shallow A-zone and deeper B-zone well installation and sampling. In late 1992, HLA completed contingency work to provide additional information for the RI.
- In October 1995, monitoring wells IR-03MW369A, -370A, and -371A were installed adjacent to the shoreline.

2.1.3.1.1 Aquifer Characteristics

The A-aquifer is generally unconfined and consists primarily of saturated artificial fill. The top of the A-aquifer is defined by the groundwater table, which is generally 7 to 12 feet bgs. The bottom of the aquifer is defined by the upper surface of Bay mud deposits. The B-aquifer is generally confined and consists of undifferentiated sedimentary deposits. The top of the B-aquifer is defined by the bottom surface of the Bay mud deposits; its bottom is defined by the upper surface of the Franciscan Complex bedrock.

2.1.3.1.2 Water-Level Elevations

Groundwater flow in the A-zone is complex because of the heterogeneity of the subsurface fill materials, tidal influences, and, possibly, effects of storm drain and sanitary sewer systems. The groundwater flow direction in the A-aquifer, along the south shore of IR-03, is generally inland in a northeasterly direction. The regional groundwater flow is likely controlled by the storm drain and/or sanitary sewer systems, which are reportedly in very poor condition and may be acting as sinks. This flow direction may change in the future if these systems are modified or abandoned. Vertical gradients between the B- and A-waterbearing zones are consistently upward, despite tidal fluctuations.

2.1.3.1.3 Extent of Chemicals in Groundwater

The EE/CA (Attachment A) summarizes the analytical results for groundwater samples collected at IR-03. The majority of sampling was conducted during historical RI activities between 1990 and 1992 (Appendix B of Attachment A). A few wells were sampled in 1995 and the three new wells installed near the shoreline were sampled in 1996. VOCs, SVOCs, PCBs, total petroleum hydrocarbons (TPHs), pesticides, and metals have been detected in groundwater samples at IR-03.

The criteria used to screen the detected organic and inorganic chemicals in groundwater are the water quality objectives for protection of human health and aquatic life given in the Enclosed Bay and Estuary Plan (SWRCB 1993). These screening criteria were chosen to be consistent with the approach presented for the Site IR-1/21 EE/CA Industrial Landfill Groundwater Plume evaluation (PRC 1996b). The IR-1/21 site is also located in Parcel E, HPS, and borders on San Francisco Bay, as does IR-03.

Organic compounds were detected in groundwater samples collected from wells throughout the site. The organic chemicals detected at concentrations exceeding screening criteria [presented in the Enclosed Bay and Estuary Plan (SWRCB 1993)] are shown on Figure 3-7 of Attachment A. The most frequently detected chemicals exceeding screening levels are PAHs and Aroclor-1260. No organic compounds exceeding screening criteria were detected in the wells located closest to the shoreline. No organic chemicals were detected in the B-zone well in IR-03.

Inorganic chemicals dissolved in groundwater exceeding the screening criteria are shown on Figure 3-9 of Attachment A. Metals detected in groundwater at IR-03 at concentrations exceeding screening criteria include arsenic, beryllium, cadmium, copper, lead, mercury, nickel, silver, thallium, and zinc. The most frequently occurring inorganic chemicals in groundwater are copper, lead, and beryllium. No inorganic chemicals exceeding screening criteria were detected in the wells located closest to the shoreline in the vicinity of IR-03. This figure was developed to be consistent with the IR-1/21 EE/CA technical approach but may not present all relevant data since the detection limits are higher than the low screening criteria. However, this action will use the presence of TPH compounds as the indicators for the hazardous substances and the presence of TPH compounds will be used to define the extent of affected soil and groundwater.

TPH compounds detected in groundwater and the maximum concentration detected are shown in Figure 3-8 in Attachment A, which also presents the historical measurements of floating product in the wells at IR-03. Screening criteria for TPH in groundwater are not available. No TPH compounds were detected in the wells located closest to the shoreline in the vicinity of IR-03.

2.1.3.1.5 Characteristics of Oil

The oily waste product in IR-03 is an aged, light non-aqueous phase liquid (LNAPL) with physical characteristics similar to those of a used motor oil. Grab samples of the free-phase product floating on the water table have been collected from four wells in the vicinity of IR-03 and analyzed for metals, VOCs, SVOCs, PCBs/pesticides, total recoverable petroleum hydrocarbons (TRPH), TPH as diesel, density, and ignitability. The minimum and maximum concentrations of these compounds are summarized in Table 3-1 of Attachment A. As shown, the oil contains several hazardous substances including SVOCs, PCBs, and metals constituents. The historically measured depths of floating product are shown on Figure 3-8 of Attachment A.

Data from a product sample collected in February 1996 indicate that less than 10 percent of the oil product has a boiling point less than 500°F. In contrast, 100 percent of gasoline, approximately 50 percent of diesel, and approximately 20 percent of Bunker C oil has a boiling point less than 500°F. These data indicate that only a small fraction of the oil has potentially significant volatility. This trait has a favorable effect on the health risk associated with inhalation pathways, but also strongly limits the ability to recover waste oil product by processes such as soil-vapor extraction.

2.1.3.2 Previous Oil Recovery Efforts

An oil recovery pilot study was conducted in early 1991 to assess whether oil could be pumped from the subsurface at IR-03 under ambient conditions (HLA 1991b). This test entailed pumping four wells that initially contained over 6 inches of floating product. The wells were pumped every few weeks with a total of six pumping events over three months. Total product recovery from all of the wells was approximately 25 gallons and ranged from less than 1.2 gallons recovered from well IR-03MW218A1 to 17.3 gallons from well IR-03MW0-3. Results of the test indicate that removing product by pumping from wells is relatively inefficient. However, with intermittent product recovery, it may be possible to remove at least a small portion of the oil from the subsurface.

2.1.4 Release Or Threatened Release Into The Environment Of A Hazardous Substance, Pollutant, Or Contaminant

Contaminants associated with IR-03 include heavy metals such as arsenic, chromium, lead, and mercury; SVOCs; and PCBs. These contaminants are hazardous or toxic substances as defined by CERCLA, Section 101(14), or the Toxic Substance Control Act (TSCA).

2.1.5 National Priorities List Status

Because the past shipyard operations had left hazardous materials on site, HPS was placed on the NPL in 1989 as a Superfund site pursuant to CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA). In 1991, HPS became slated for closure pursuant to the terms of the Defense Base Realignment and Closure Act of 1990 (Public Law 101-510). Closure activities at HPS include environmental remediation and making the property available for nondefense use.

2.1.6 Maps, Pictures, and Other Graphic Representations

The EE/CA report, Attachment A of this action memorandum, presents Figures 1-1 through 6-1 and Tables 2-1 through 7-2. Section 3.0 of the EE/CA characterizes the contaminants associated with Site IR-03.

2.2 OTHER ACTIONS TO DATE

Previous removal activities conducted at HPS include (1) PCB cleanup at IR-08, (2) the Tank S-505 removal action, (3) underground storage tank (UST) removals, (4) sandblast grit fixation, and (5) the IR-06 Tank Farm removal action. These actions are discussed in the Exploratory Excavations EE/CA report (PRC 1996a).

Current or recently completed removal activities include:

- the pickling and plating yard (PPY) removal action
- the exploratory excavation removal action
- the storm drain system removal action
- the IR-1/21: Industrial Landfill Groundwater Plume removal action
- the IR-06 soil removal action.

The PPY removal action is complete and consisted of the removal of hazardous materials and the decontamination and removal of structures at the PPY. The exploratory excavation removal action will involve excavation and off-site disposal of contaminated soil at 18 sites across HPS. The storm drain system removal action will involve cleaning out and disposing of sediments from lines, manholes, and catch basins of the storm drain system at HPS. The IR-1/21 removal action will include source control and remediation or isolation of groundwater. The IR-06 removal action will involve excavation and treatment or disposal of affected vadose-zone soil. No other removal actions have been conducted at Site IR-03.

2.3 STATE AND LOCAL AGENCY ROLES

Federal Executive Order 12580 delegates the President's authority to undertake CERCLA response actions to the Department of Defense. Congress further outlines this authority in its Defense

Environmental Restoration Program (DERP) Amendments, which are presented in 10 United States Code (U.S.C.) 2701-2705. Both CERCLA 120(f) and 10 U.S.C. 2705 require Navy facilities to ensure that state and local officials be given the timely opportunity to review and comment on Navy response actions.

Accordingly, DTSC and RWQCB are representing the state during activities that are part of the Navy's CERCLA response program at HPS. State input was solicited by providing DTSC and RWQCB with the opportunity to review and comment on the draft EE/CA report.

As lead agency, the Navy has authority over overall public participation activities. To foster community awareness and public input, the Navy has an established community relations program at HPS. The Navy regularly publishes fact sheets and public notices to announce environmental restoration activities at HPS. An important part of the community relations program is the HPS restoration advisory board (RAB). The HPS RAB meets on a monthly basis as a forum for interested parties to receive information and provide comment on HPS documents and environmental activities.

For this removal action, the Navy's community relations activities included publishing a public summary and holding a public comment period for the EE/CA report. In April 1996, the Navy distributed a public summary summarizing the removal action process and the EE/CA report. The EE/CA report (Attachment A) was released for public review and comment. The public comment period on the EE/CA was announced in the *Independent* and started on July 16, 1996, and continued until August 12, 1996. A summary of the public comments received and the Navy's responses to these comments are included in the responsiveness summary (Attachment C).

3.0 THREATS TO PUBLIC HEALTH, WELFARE, OR THE ENVIRONMENT AND STATUTORY AND REGULATORY AUTHORITIES

Because hazardous substance-affected soil, groundwater, and oily waste are present at IR-03, the Navy determined, based on the eight removal action factors set forth in the 1990 National Oil and Hazardous Substances Pollution Contingency Plan (NCP), that Site IR-03 at HPS poses a substantial threat to human health or the environment and that a removal action is appropriate to mitigate the potential for exposure to hazardous substances at the Site. Two of the NCP removal factors are discussed in Sections 3.1 and 3.2 below.

3.1 THREATS TO PUBLIC HEALTH OR WELFARE

NCP Section 300.415(b)(2)(i): Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.

A potential indirect human exposure pathway to groundwater contaminants exists via ingestion of fish and other aquatic life from the Bay. Contaminated groundwater from Site IR-03 could migrate into the Bay, where aquatic organisms could bioaccumulate contaminants and, later, human receptors could ingest the organisms. There are no direct pathways for human exposure to contaminated groundwater at HPS. Access is restricted to the IR-03 area so human exposure pathways are eliminated. Human exposure through the ingestion of drinking water is not a pathway since groundwater and surface water at HPS are not used for domestic drinking water; nor are they considered a likely future source of drinking water.

Typically, a site-specific fate and transport analysis, ambient level comparison, and health assessment would be conducted to evaluate contaminant levels that present a threat to receptors. This type of analysis is beyond the scope of this removal action and will be addressed in the RI/FS program. Therefore, as recommended by the regulatory agencies, the threat posed by the contaminated groundwater was evaluated qualitatively. Two factors were used for this evaluation: (1) contaminant toxicity, and (2) proximity of contaminants to the Bay.

Relative contaminant toxicity was evaluated by screening the groundwater data against published water quality objectives for protection of human health and aquatic life. The screening criteria were derived by use of the lowest value of the water quality objectives contained in the Enclosed Bay and Estuary Plan for protection of human health and aquatic life. At Site IR-03, VOCs, PAHs, PCBs, and inorganic (metal) constituents in groundwater exceed screening criteria. The highest threat is posed by groundwater with contaminant concentrations that consistently exceed screening criteria by a significant amount (more than 5-10 times). These contaminants are more likely to migrate into the Bay at elevated concentrations and may pose a threat to receptors. Additionally, the evaluation also considered the close proximity of IR-03 to the Bay. In that IR-03 is next to the Bay, migration of the contaminants into the Bay is more likely than from the other sites. The Navy believes that published values do not take into account site-specific fate and transport mechanisms or ambient levels; therefore, they may be conservative indicators of potential human health and environmental threats.

3.2 THREATS TO THE ENVIRONMENT

NCP Section 300.415(b)(2)(i): Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.

Site IR-03 is adjacent to San Francisco Bay. Therefore, a higher risk pertains than at other sites of environmental effects from migration of groundwater contaminants into the Bay. As indicated in the previous section, the site-specific evaluation of the threat posed by contaminants will be conducted in the RI/FS process. For this removal action, the factors evaluated were contaminant toxicity screening criteria and proximity to the Bay. These same factors were evaluated for threats to public health, and they are described in section 3.1.

4.0 ENDANGERMENT DETERMINATION

Qualitative risk evaluations for the removal action and other information contained in the administrative record indicate that current conditions in the groundwater at IR-03 may present imminent threats to the aquatic ecosystem, public health, welfare, or the environment.

If the removal action described in this action memorandum is delayed or not implemented, actual or threatened releases of hazardous substances from Site IR-03 may present an imminent and substantial endangerment to the environment.

5.0 PROPOSED REMOVAL ACTIONS AND ESTIMATED COSTS

This section discusses the proposed removal action, its contribution to remedial performance, a description of alternative technologies, the EE/CA report, applicable or relevant and appropriate requirements (ARARs), the removal action schedule, and estimated costs.

5.1 PROPOSED ACTION DESCRIPTION

The preferred alternative is Alternative 1 based on the discussion and analysis presented in Chapters 6.0 and 7.0 of the EE/CA (Attachment A). This alternative reduces the threat of migration of IR-03 contaminants to San Francisco Bay, is consistent with future remedial actions, and meets ARARs. This alternative includes the installation of sheet piles to reduce the threat of contaminant migration to the Bay. Sheet piles are interlocking steel sheets that are driven into the ground to form a subsurface barrier between IR-03 and the San Francisco Bay. The piles will be driven into the ground until they reach an underground natural layer of clay (Bay mud). This layer will limit the amount of contamination that can migrate under the wall. Near the shoreline at IR-03, clay exists at about 18 to 25 feet bgs and the sheet piling will extend approximately 2 feet into the Bay mud to establish an effective seal.

Implementation of Alternative 1 consists of the activities summarized in the following list, and described in more detail in the next few paragraphs.

- Sample soil, as a pre-installation measure, from ground surface to 25 feet bgs to verify the lateral and vertical extent of soil contamination. This sampling will verify the lateral length of the sheet pile barrier.
- Conduct "geo-probe" or cone penetration testing (CPT) along the proposed wall location to check for obstructions in the fill material, and to delineate the Bay mud/artificial fill interface.
- Drive interlocking steel sheet pile sections approximately 2 feet into Bay mud using resonant, vibratory, or hydraulic hammering equipment.
- Grade and place a 6-inch layer of clay material over the entire known area of affected subsurface. Top it with a 1-foot layer of seeded, fertilized topsoil.

A pre-installation investigation will be conducted before installation of the wall along the proposed wall length (Figure 6-1 in Attachment A) to verify the lateral and vertical extent of affected soil, to identify potential obstructions in the fill material and delineate the Bay mud/artificial fill interface. The proposed wall alignment is preliminary and will be revised based on data gathered in the pre-installation investigations. Soil borings will be drilled to depths of approximately 25 feet bgs according to a systematic grid sampling approach for approximately every 50 linear feet of sheet pile, resulting in a total of approximately 16 soil borings. Soil borings will be drilled using a "geo-probe rig" or CPT methods.

The sheet pile barrier will be approximately 800 feet long, to a maximum depth of approximately 27 feet bgs, just inside the riprap shoreline of the Bay. While the sheet pile barrier will not completely surround the IR-03 former waste oil ponds, its placement will better isolate the area from the Bay assuming that groundwater flow will eventually return to a natural direction from inland to the Bay. The wall will be installed to curve around the sides of the former oil pond perimeter in a half-ellipse shape. The wall will be installed down through the saturated soil to the Bay mud which occurs about 18 to 25 feet bgs. The wall will be installed approximately 2 feet into Bay mud to form a continuous low permeability barrier.

As an option for any future final remedial action involving soil excavation proposed for Parcel E, the sheet pile barrier may be designed for use as shoring utilizing a series of tiebacks and passive resistance derived from the depth of the wall. Additionally, the sheet piling may be extended horizontally through installation of additional interlocking sheet piles should a future final remedial action proposed for Parcel E include such a barrier.

Site restoration activities under this option would include scraping and grading operations to place a 6-inch clay layer covered with a 1-foot topsoil layer over the entire known area of affected subsurface. The clay layer will be placed to minimize rainfall infiltration over the area and to limit the effects of contaminated groundwater and contaminated soils left in place. The topsoil will be placed and seeded with native grass (with consideration given for listed California plants) to complete the site restoration. Seeding is recommended for erosion control purposes until such time as a final remedial action is implemented for Parcel E. The backfill shall be appropriately graded to allow for proper surface runoff/drainage over the area. The size of area to be covered will be the area where affected soils were identified in previous investigations. This area will approximately cover the limits of proposed excavation 0-15 bgs as identified in Figure 6-1 of Attachment A.

5.2 PROPOSED ACTION CONTRIBUTION TO REMEDIAL PERFORMANCE

As part of the remedial investigation process for each parcel, a detailed risk evaluation will be conducted on the soil, groundwater, and oily waste. If risk exists, remediation will be addressed in the Parcel E Feasibility Study. The removal action is intended to advance the status of Site IR-03 toward remediation and address immediate contaminant migration concerns. This action is consistent with the final action at the Site because it can accommodate soil removal as well as subsurface barrier extension, described above, if needed.

5.3 DESCRIPTION OF ALTERNATIVE TECHNOLOGIES

Three removal alternatives were developed to meet the RAOs for the Site IR-03 removal action, and those are summarized in the following paragraphs. The summaries highlight the effectiveness, implementability, and cost effectiveness of the alternative technologies.

Alternative 1: Installation of a Sheet Piling Subsurface Barrier. This alternative provides a low permeability barrier between the former waste oil ponds and the San Francisco Bay. This alternative is not complex and can be rapidly implemented, although sheet piling installation may be problematic because of the potential for encountering subsurface obstacles. The pre-installation investigation will assist in assessing subsurface lithology and presence of rubble and other obstacles. This technology does allow for construction around limited obstructions. Additionally, the top surface of the entire site will be regraded with a 6-inch clay layer and covered with 1 foot of topsoil. This surface replacement will reduce surface-water infiltration, control dust, and improve surface drainage characteristics.

Alternative 2: Excavation Below Water Table, Off-Site Disposal, Product Removal and Recycling, Backfill with New Fill. Alternative 2 includes excavating all affected soils and product to 25 feet bgs with disposal of excavated affected soil and recovered product off site. This alternative provides the highest degree of removal; however, it is relatively problematic to implement in the Site's saturated soils, and it is much more costly than excavating to just below the water table surface. This alternative provides the highest degree of protection of San Francisco Bay and is consistent with future remedial action because it removes most of the contaminants associated with IR-03. However, because of the saturated excavation conditions, it will be difficult to verify that all product and product-affected soils have been removed. Since the excavation will remove most of the contaminants associated with IR-03 and replace them with clean fill, it would greatly reduce the potential for human exposures, including potential exposures to soil containing hazardous substances.

Alternative 3: Excavation to Water Table, Off-Site Disposal, Product Removal and Recycling, Backfill with New Fill, Installation of a Sheet Piling Subsurface Barrier. Alternative 3 includes excavating hazardous substances, product, and product-affected soil to just below the water table, disposing of the excavated soil and recovered product off site, and placing clean overburden and new fill. This alternative also includes installation of a sheet piling subsurface barrier to provide a low permeability barrier between the residual product below the water table and San Francisco Bay. The sheet pile barrier will also serve as shoring during excavations next to the Bay. This alternative would be effective in removing accessible soil and free product above the water table, and provide containment of affected materials not removed below the water table. This alternative is readily implemented using traditional construction techniques. Since the excavation will be restored with clean fill, it would greatly reduce the potential for human exposure, including potential exposures to soil containing hazardous substances. This alternative is compatible with future remedial action since the sheet piling can be extended horizontally if additional barriers are part of the final remedial action.

Sections 6.0 and 7.0 of the EE/CA (Attachment A) provide a more detailed description of removal action technologies and alternatives.

5.4 EE/CA REPORT

An EE/CA report (Attachment A) has been developed for this non-time-critical removal action. The EE/CA report identifies and compares several cleanup alternatives for the oily waste and hazardous substances at Site IR-03. The preferred alternative proposed in the EE/CA was Alternative 1. The EE/CA report was released for public review and comment on July 16, 1996. The public comment period on the EE/CA is 30 days and will be complete on approximately August 15, 1996. A summary of the comments received and the Navy's responses to these comments is included in the responsiveness summary (Attachment C).

5.5 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section presents description of federal ARARs and TBCs and the Navy's determination of which state ARARs apply to this removal action, in respect to current site data. The EE/CA report (Attachment A) provides a similar discussion. ARARs and TBCs are generally divided into three categories: chemical-specific, location-specific, and action-specific. The following subsections discuss these ARARs, TBCs, and other requirements for the IR-03 removal action.

Chemical-Specific ARARs and TBCs

Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical cleanup values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

The scope of the removal action does not include groundwater or adjacent surface water restoration; rather the action is only for containment. Therefore, it is beyond the scope of this removal action to identify chemical-specific ARARs. During the RI/FS, chemical-specific ARARs will be identified for the groundwater.

Location-Specific ARARs and TBCs

Location-specific ARARs restrict actions or affected concentrations in certain environmentally sensitive areas. These requirements may limit the type of removal action that could be implemented, and may impose additional constraints on cleanup levels. Examples of environmentally sensitive locations include wetlands, coastal zones, and areas or buildings of archaeological or historical significance. The existence of endangered or threatened species within the area must also be considered.

No historical buildings or architectural, archaeological, or cultural resources exist within Parcel E (HPS BRAC Cleanup Plan). Therefore, ARARs such as the Antiquity Act or Archaeological Resources Protection Act were not included as potential ARARs.

Three potential ARARs were identified as potentially applicable to the removal action and have been included within Table 4-1 of Attachment A. The Protection of Wetlands Executive Order 11990 was included as an ARAR because of the designated wetland areas known to exist within Parcel E. The two nearest wetland areas to IR-03 are located approximately 1,200 feet to the southeast and northwest of the Site. However, removal activities are not planned for these areas. Removal activities would be specifically designed to avoid these areas in the future.

Since IR-03 is located in a coastal zone with intertidal mud flats directly adjacent to the Site, the Coastal Zone Management Act and California Coastal Act have been included as ARARs. However, removal activities would be restricted to inland areas with engineering controls used to prevent both water and airborne spread of site-affected materials to coastal areas and intertidal mudflats. Section 30232 of the California Coastal Act specifically allows for "effective cleanup facilities" to address affected sites with hazardous and petroleum wastes and to prevent spills of such waste during transportation activities. Removal activities would be designed to limit the possibility of spills of product or product-affected soils, provide facilities for effective cleanup should such a spill occur, and in general, remove of effectively contain product and product-affected soils.

The HPS BRAC Cleanup Plan identifies seven threatened and endangered species within the HPS boundaries, including two species of salt water fish and five bird species. For this reason, the Endangered Species Act has been included as a federal ARAR. Additionally, the BRAC Cleanup Plan has identified 21 species of animals listed as California special status animals and 2 species of plants listed as California special status plants. For this reason, the California Endangered Species Act has also been included as a state ARAR. However, removal activities would be restricted to inland areas with engineering controls used to prevent the spread of both water- and airborne-affected materials to affected animal or plant species. Completion operations at the Site would return any excavated areas to pre-existing conditions and reseeding would include consideration for listed California plants. Disturbance of any endangered species or their habitats is unlikely during removal activities.

Action-Specific ARARs and TBCs

Action-specific ARARs should be tailored to the on-site activities that are part of the selected removal action alternative. Action-specific ARARs do not determine the removal alternative; rather, they indicate how to implement an alternative. These regulations define the performance, design, or other similar action-specific controls or restrictions on activities related to the management of hazardous substances. Table 4-2 of Attachment A presents potential action-specific ARARs. The following is a general discussion of the action-specific ARARs. After selection of a removal action alternative, the action-specific ARARs should be reviewed for applicability to the selected removal action.

The proposed remedial alternative at IR-03 will not likely involve any significant excavation, storage, and off-site disposal of wastes. However, any soil or groundwater generated as part of the removal actions will be characterized and managed appropriately in compliance with the substantive requirements of RCRA. In addition, any transportation of hazardous wastes off site will comply with the requirements of the Department of Transportation regulations (40 CFR Part 107).

Similar to RCRA, several Clean Air Act (CAA) regulations are applicable or relevant and appropriate to the remedial alternatives presented in this EE/CA. The CAA is a state-delegated program within

California. Potential action specific ARARs are found within California's State Implementation Plan (SIP). The local Bay Area Air Quality Management District (BAAQMD) has established requirements for excavating, aerating, and stockpiling soils affected with VOCs. Additionally, the BAAQMD sets requirements for fugitive dust generated from construction sites. These requirements apply to removal activities proposed at IR-03 for soil excavation or stockpiling activities.

Other Requirements

The following requirement is applicable to this removal action but is not considered an ARAR:

- **CERCLA Off-Site Rule:** Applicable to off-site disposal of wastes generated from limited excavation.
- **Excavation-Related Requirements**: The removal alternative may require limited excavation of soil. Excavation requirements include Occupational Safety and Health Administration trenching and shoring requirements.

5.6 PROJECT SCHEDULE

The removal action process will begin with the submission of the removal action work plan in August 1996. Field implementation of the removal action is anticipated to begin during fall 1996 and last approximately three months. Once the removal action is complete, a removal action summary report will be prepared to document the field activities and analytical results for the preinstallation investigation.

5.7 ESTIMATED COSTS

A detailed cost estimate for the pre-installation investigation, installation of a subsurface barrier and the surface replacement is provided in Table 7-2 of Attachment A, with details and limitations presented in Appendix A of the EE/CA (Attachment A). A summary of costs is provided below:

Sheet Piling Subsurface Barrier	**$685,000**
Surface Replacement with clay/topsoil layers	**140,000**
Pre-Installation Soil Sampling	**52,000**
TOTAL	**$877,000**

Actual costs may vary depending on the subcontract negotiated with the construction firm completing the work and subsurface conditions.

6.0 EXPECTED CHANGE SHOULD ACTION BE DELAYED OR NOT TAKEN

If the removal action is delayed, contamination could spread to other areas of HPS and threaten the San Francisco Bay. The result will be further soil and groundwater contamination and potential impact on the San Francisco Bay.

7.0 OUTSTANDING POLICY ISSUES

No outstanding policy issues exist for this removal action.

8.0 RECOMMENDATION

This action memorandum represents the selection of containment of oily waste and hazardous substances for the removal action at IR-03 at HPS in San Francisco, California. The action was developed in accordance with CERCLA as amended by SARA and is consistent with the NCP. Conditions at the sites indicate that a removal action is appropriate in accordance with Title 40 CFR, Section 300.415(b)(2), criteria for a removal. This decision is based on the administrative record for this action. The index to the administrative record for this action is included in Attachment B to this action memorandum.

ATTACHMENT A
SITE IR-03 REMOVAL ACTION
ENGINEERING EVALUATION/COST ANALYSIS
WASTE OIL RECLAMATION PONDS

FINAL

October 18, 1996

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN II)
Northern and Central California, Nevada, and Utah
Contract No. N62474-94-D-7609
Contract Task Order No. 007

Prepared for

DEPARTMENT OF THE NAVY
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HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

ENGINEERING EVALUATION/COST ANALYSIS
SITE IR-03 REMOVAL ACTIONS
WASTE OIL RECLAMATION PONDS
FINAL

October 18, 1996

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ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
BAAQMD	Bay Area Air Quality Management District
BRAC	Base Realignment and Closure Act
bgs	below ground surface
CAA	Clean Air Act
CAMU	Corrective Action Management Unit
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Resources, Conservation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long Term Environmental Action Navy
CTO	Contract Task Order
DTSC	Department of Toxic Substances Control
EE/CA	Engineering Evaluation and Cost Analysis
EFA WEST	Navy Engineering Field Activity West
EPA	Environmental Protection Agency
FS	Feasibility Study
HMTA	Hazardous Materials Transportation Act
HPA	Hunters Point Annex
HPAL	Hunters Point Ambient Level
HSWA	Hazardous and Solid Waste Amendments
IR	Installation Restoration
LLNL	Lawrence Livermore National Laboratory
LNAPL	Light Non-Aqueous Phase Liquid
LUFT	Leaking Underground Fuel Tank
mg/kg	milligrams per kilogram
msl	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated biphenyl
PRG	Preliminary Remediation Goal

ACRONYMS AND ABBREVIATIONS (continued)

RAO	Removal Action Objectives
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendment and Reauthorization Act
SIP	State Implementation Plan
SVOC	Semivolatile Organic Compound
TBC	To Be Considered
TCLP	Toxic Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbon
TPRH	Total Recoverable Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
TTLC	Total Threshold Limit Concentrations
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

This engineering evaluation/cost analysis (EE/CA) was prepared for the U.S. Department of the Navy (Navy) in accordance with current U.S. Environmental Protection Agency (EPA) documents for a non-time-critical removal action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This report summarizes the EE/CA process, develops removal action goals and objectives, reviews and evaluates viable process options, combines process options into feasible alternatives, and provides recommendations.

Site IR-03 ("the Site") is the location of two Navy operated former waste oil reclamation ponds which were in use from 1944 until 1974 at Hunters Point Annex (HPA). The Site is located in Parcel E, along the south eastern shoreline of HPA and is completely surrounded by IR-02 (Figure 1-1 and 1-2). The unlined ponds were constructed from fill material and located approximately 30 feet from the San Francisco Bay shoreline. An Initial Assessment Study (IAS) estimated that approximately 0.6 to 2.0 million gallons of oily wastes were received annually at the reclamation ponds. Reclaimed oil was removed periodically by a private contractor who sold much of it for road oil. Recent sampling events have confirmed the presence of hazardous substances and oily waste including free-phase petroleum products in the general vicinity of the former waste oil ponds from existing surface levels to approximately 25 feet below ground surface (bgs). Hazardous substances (including metals, semivolatile organic compounds [SVOCs] and volatile organic compounds [VOCs]) appear to be commingled or constituents of the oily waste. This removal action will use the presence of visible free-phase product, product-affected soils and dissolved TPH compounds as the indicators for the extent of hazardous substances.

CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (Title 40 Code of Federal Regulations [40 CFR] Part 300) define removal actions as the cleanup or removal of released hazardous substances, actions to monitor the threat of release of hazardous substances, and actions to mitigate or prevent damage to public health or welfare or the environment. The removal action for IR-03 was authorized following consideration of the following appropriateness factors as listed within 40 CFR Part 300.415:

- "The actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants."

- "High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may migrate."

This removal action is designed to reduce the threat of contaminants in the vicinity of the IR-03 former waste oil reclamation ponds from migrating to the San Francisco Bay. This removal action will be consistent with future actions planned at HPA, will comply with applicable or relevant and appropriate requirements (ARARs) and will protect human health and the environment.

The following Removal Action Objective (RAO) has been established for the project:

- Limit potential migration of contaminants in groundwater associated with the IR-03 former waste oil ponds to the San Francisco Bay.

The EE/CA identified general response actions that could be used at the Site including: removal, control, treatment, disposal, and restoration response actions. For each of these response actions, the specific technology process options that would be applicable for IR-03 were identified. The most promising process options were evaluated for their overall effectiveness, implementability and cost-effectiveness with respect to meeting the RAO. These evaluations are summarized in Tables 6-1 and 6-2. Through combination of the separate options, a set of remedial alternatives was assembled and evaluated. The three remedial alternatives are:

Alternative 1: Installation of a Sheet Piling Subsurface Barrier

Alternative 2: Excavation Below Water Table, Off-Site Soil Disposal, Product Removal and Recycling, Backfill with New Fill

Alternative 3: Excavation to Water Table, Off-Site Soil Disposal, Product Removal and Recycling, Backfill with New Fill, Installation of a Sheet Piling Subsurface Barrier

Chapter 7.0 presents a summary of each alternative's relative effectiveness, implementability and cost-effectiveness. The preferred alternative is Alternative 1 based on the discussion and analysis presented in Chapters 6.0 and 7.0. This alternative reduces the threat of migration of IR-03 contaminants to the San Francisco Bay and is consistent with future remedial actions and meets ARARs. This alternative reduces the threat of contaminant migration to the Bay by installing sheet pile, but does not remove or remediate groundwater. Removal and/or control of source contaminants and final remediation/removal of groundwater, will be addressed as part of the Parcel E Feasibility Study. Sheet pile are interlocking steel sheets that are driven into the ground to form a subsurface barrier between IR-03 and the San Francisco Bay. The piling will be driven into the ground until they reach an underground, natural layer of clay (Bay mud). This layer will limit the amount of contamination that can migrate under the wall. Near the shoreline at IR-03, clay exists at about 18 to 25 feet bgs and the sheet piling will extend approximately 2 feet into the Bay mud to establish an effective seal. Additionally, the ground surface of the entire site will be regraded with a 6-inch clay layer and covered with 1 foot of topsoil. This surface replacement will reduce water infiltration, control dust, and improve surface drainage characteristics.

Additional field work will be necessary to finalize implementation of Alternative 1. The objectives of the pre-installation investigation are to (1) confirm that the lithology is favorable for driving sheet piling along the proposed alignment which is adjacent to the shoreline, (2) further delineate the depth to the Bay mud/artificial fill interface along the wall alignment, and (3) verify the lateral and vertical extent of indicator compounds associated with the IR-03 contaminants. Based on the data gathered during the pre-construction investigation, the removal action design will be revisited to ensure constructability.

CHAPTER 1.0
INTRODUCTION

This engineering evaluation and cost analysis (EE/CA) has been prepared on behalf of the U.S. Department of the Navy ("Navy") to evaluate removal action options for hazardous substances and oily waste in the vicinity of two former waste oil reclamation ponds at Hunters Point Annex (HPA) in San Francisco, California ("the Site").

The Engineering Field Activity West, Naval Facilities Engineering Command (EFA WEST) authorized these activities as part of Contract Task Order (CTO) No. 007 under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62474-94-D-7609, which has been issued to PRC Environmental Management, Inc. ("PRC"). Levine·Fricke, Inc. ("Levine·Fricke") has subcontracted with PRC to prepare this EE/CA for the Navy.

This EE/CA report is intended to provide information to interested Navy, community, and regulatory agencies, particularly the U.S. Environmental Protection Agency (EPA) Region 9, the Department of Toxic Substances Control (DTSC) Region 3, and the Regional Water Quality Control Board-San Francisco Bay Region (RWQCB). The Navy is working with the EPA, DTSC, and RWQCB in developing and implementing cleanup activities at HPA.

The HPA was placed on the National Priorities List in 1989 as a Superfund site, pursuant to the Comprehensive Environmental Resource, Conservation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and pursuant to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The Navy, EPA, DTSC, and RWQCB, would like to accelerate the overall environmental restoration strategy at the HPA Superfund site to provide for more timely and efficient cleanup.

Removal strategies could be used in the CERCLA and NCP framework to achieve an accelerated cleanup. CERCLA and the NCP define removal actions to include "the cleanup or removal of released hazardous substances from the environment, such actions as may necessarily be taken in the event of the threat of a release of hazardous substances into the environment, such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removed material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release."

The EPA has identified three types of removal actions: emergency, time critical, and non-time-critical. The proposed removal action for the waste oil reclamation ponds has been classified as a non-time-critical removal action since it does not pose an immediate threat to public health, welfare, or the environment, and therefore, a planning period of more than six months is appropriate.

This EE/CA will provide information to decision makers on the effectiveness, implementability, and cost of potential remedial options. It will also provide a rationale and basis for selecting a preferred remedial alternative, and will satisfy administrative requirements. The information provided in the EE/CA will be incorporated into the Parcel E Feasibility Study (FS) for determining a parcel-wide final remedy.

As discussed previously, the EE/CA will address contaminants associated with IR-03 (oily waste and hazardous substances) in the vicinity of two former waste oil reclamation ponds. The remedial options evaluated address containment, and removal and disposal of the hazardous substances based on the extent of the indicator compounds. A more comprehensive analysis of final remedial options will be conducted on a parcel-wide basis during the Parcel E FS.

EE/CA ORGANIZATION

This report is consistent with the EPA's, "Guidance on Conducting Non-Time Critical Removal Actions under CERCLA" (EPA 1993). The report is organized into the following eight chapters:

<u>Chapter 1</u> provides introductory comments about the project including regulatory framework and report organization.

<u>Chapter 2</u> provides general information about the site's setting, characteristics, and historical site usage.

<u>Chapter 3</u> presents the results of previous investigations regarding the nature and extent of chemicals at the Site.

<u>Chapter 4</u> discusses the scope, goals, and objectives of the removal action. Potentially applicable or relevant and appropriate requirements (ARARs) and site data are reviewed to develop removal action objectives.

<u>Chapter 5</u> screens remedial process options to identify those technologies most suitable for the removal action near the former reclamation ponds.

<u>Chapter 6</u> presents a detailed description and analysis of process options retained following screening. These options are evaluated with respect to effectiveness, implementability, and cost.

<u>Chapter 7</u> identifies and evaluates comprehensive removal alternatives developed from a combination of the most promising process options. Based on this evaluation, the removal alternative is recommended.

<u>Chapter 8</u> presents a list of referenced material.

CHAPTER 2.0
SITE DESCRIPTION AND BACKGROUND

2.1 DESCRIPTION

The former waste oil reclamation ponds ("IR-03"), named IR-03 under the Installation Restoration Program, are located along the southeastern shoreline in Parcel E at HPA (Figures 1-2 and 2-1). The IR-03 area is a subarea of the larger site, IR-02. No buildings are present on site; the area is unpaved and generally unvegetated. Concrete block riprap has been placed on the shoreline adjacent to the Site. The Site is flat, with surface elevations ranging from 5.6 to 9.5 above mean sea level (msl).

The following sections regarding site history, geology, and hydrogeology are summarized from the information presented in Appendix B.

2.2 SITE HISTORY

The Navy operated two waste oil reclamation ponds on the south shore of HPA (Figures 1-2 and 2-1) from 1944 to 1974 (WESTEC 1984). The unlined ponds, covering approximately one-third acre, were constructed from fill material and located approximately 30 feet from the San Francisco Bay shoreline. Oily wastes from ships and shipyard operations were hauled by truck or pumped through a pipeline from Berth 29 and disposed of in the ponds. Subsurface steam pipes were used to heat the liquid to facilitate oil/water separation, and water drawn off during the process was discharged to San Francisco Bay. The reclaimed oil was removed approximately three times a year by a private contractor, who sold much of the reclaimed oil for road oil.

The Initial Assessment Study estimated that approximately 0.6 to 2.0 million gallons of oily waste were received annually at the oil reclamation ponds (WESTEC 1984). Reclaimed oil was removed periodically by a private contractor who sold much of it for road oil. It was also reported that one pond was 50 by 60 feet wide by 5 feet deep with a capacity of 190,000 gallons and the other was 55 by 100 feet wide by 5 feet deep with a capacity of 250,000 gallons. The ponds were backfilled by the Navy in 1974. There is no indication that cleanup of the underlying oily soil occurred before filling. Additionally, Triple A, a HPA tenant, disposed of sandblast and liquid wastes at IR-03 and a portion of adjoining IR-02.

2.3 ENVIRONMENTAL SETTING

2.3.1 Climate and Meteorology

The climate at IR-03 is characterized by partly cloudy, cool summers with little precipitation and mostly clear, mild, wet winters. The average rainfall for the area is 19.71 inches per year. Meteorological data from the San Francisco Airport, located approximately 8 miles south of HPA, indicate that the prevailing wind direction is from the west-northwest. The average and maximum wind speeds at HPA are approximately 10 and 23 miles per hour, respectively (PRC/HLA 1993).

2.3.2 Natural Resources

The habitat in the IR-03 area is highly altered and disturbed from previous human activities. However, two small wetland areas have been identified in Parcel E (PRC 1995A). The areas are located approximately 1,200 feet northwest and southeast of the IR-03 area and are 1.4 acres and 0.5 acres in size, respectively (Figure 1-2). Due to the remote location in relation to IR-03, it is not anticipated that either of the wetland areas would be affected by removal action activities at IR-03.

Seven threatened, endangered, or special status species have been identified in the HPA. These include two fish and five bird species (PRC 1995A). Table 2-1 lists these species including a determination of their migratory nature.

2.3.3 Geology

The geologic units that underlie HPA from bottom to top are as follows: Franciscan Complex bedrock; undifferentiated sedimentary deposits (Qus); Bay mud deposits (Qbm); undifferentiated upper sand deposits (Quus); and artificial fill (Qaf) (PRC/ECOVA 1995).

The peninsula forming HPA is within a northwest trending belt of Franciscan Complex bedrock known as the Hunters Point Shear Zone. The rocks within this zone are intensely deformed and sheared. Serpentinite is the predominant rock type, but other rock types characteristic of Franciscan Complex bedrock are also present. Serpentinite is subdivided into two general textural types: a relatively hard serpentinite and an intensely sheared, friable, and weak to plastic serpentinite. Stronger and more brittle rock types, such as graywacke and hard serpentinite, have very low primary porosity and permeability; however, some secondary porosity and permeability result from the presence of open fractures. Surrounding the brittle rock types, sheared serpentinite and shales form a matrix of relatively fine-grained rocks with low porosity and permeability.

In the vicinity of IR-03, the top surface of the serpentinite bedrock is approximately 150 feet below ground surface (bgs). This bedrock is overlain by approximately 92 feet of undifferentiated sedimentary deposits consisting of consolidated sands and clays. These are overlain by Bay mud consisting of low permeability, soft, highly organic, plastic clay and silt with interbedded lenses of sand and peat, ranging in thickness from 25 to 30 feet. In some areas of IR-03, the Bay mud is overlain by poorly graded sands and silty sands designated as the undifferentiated upper sand deposits, which may be native or hydraulically deposited from dredging operations. The uppermost artificial fill is composed of bedrock-derived serpentine fill and industrial waste and construction debris fill.

The artificial fill includes a wide range of soil types, from stiff clays to poorly graded sands to boulder fill. In general, sandy or gravely fill immediately overlies the native Bay mud deposits. Clays typically overlie the sands and gravels. Above the clays and to the ground surface, sands that appear to be sandblast waste are frequently encountered. Borings and test pits installed in IR-03 indicate that the upper fill material is loose, heterogeneous, and contains numerous large obstructions, presumably concrete and wood construction debris. During the recent installation of wells IR03MW369A, IR03MW370A, and IR03MW371A, a magnetometer clearance survey found a relatively long, apparently continuous obstruction directly adjacent to the shoreline. This magnetic feature could be related to remaining reinforcement in shoreline concrete debris riprap, remains of a shoreline dike from the initial filling of the Site, or remains of a barrier wall constructed between the reclamation ponds and the shoreline.

2.3.4 Hydrogeology

Three aquifers have been identified at HPA and are designated the A-aquifer; the undifferentiated sedimentary aquifer, or B-aquifer; and water in localized fractures of bedrock. The A-aquifer consists of saturated fill materials and undifferentiated upper sand deposits overlying Bay mud. The A-aquifer may overlie bedrock in excavated areas next to the former shoreline. In the lowland areas of HPA, depths to groundwater range from 2 to 15 feet bgs. Some areas have a permanent water table at a depth of 30 to 60 inches bgs because of fluctuating tides. The B-aquifer consists of undifferentiated sedimentary deposits underlying Bay mud and overlying Franciscan Complex bedrock. The bedrock aquifer consists of the upper weathered and deeper fractured portions of the Franciscan bedrock. The bedrock aquifer appears to be in direct hydraulic communication with the A-aquifer where the A-aquifer directly overlies it (PRC/ECOVA 1995).

2.3.4.1 Aquifer Characteristics

Both the A- and B-aquifers were encountered at IR-03. A-aquifer characteristics are summarized as follows:

- A-aquifer consists of saturated artificial fill and, to a lesser extent, undifferentiated upper sand deposits.
- The top of the A-aquifer is defined by the groundwater table, which is generally 7 to 12 feet bgs. The bottom of the aquifer is defined by the upper surface of Bay mud deposits.
- Saturated thickness ranges from close to zero in the northern part of IR-03, to approximately 20 feet in the southern part of IR-03.
- Generally unconfined.

The saturated portions of the A-aquifer are generally unconfined but may be locally confined where fine-grained fill materials overlie coarser-grained fill materials or undifferentiated upper sands.

B-aquifer characteristics at IR-03 are summarized as follows:

- B-aquifer consists of undifferentiated sedimentary deposits.
- The top of the B-aquifer is defined by the bottom surface of the Bay mud deposits; its bottom is defined by the upper surface of the Franciscan Complex bedrock.
- Saturated thickness is approximately 100 feet at IR-03.
- Generally confined.

2.3.4.2 Water-Level Elevations

Water-level elevations at IR-03 have been interpreted from water levels in the A-aquifer (ranging from -0.86 to 0.53 feet msl in May 1995; Figure 2-2) and are presented in detail in the Final Facility-Wide Groundwater Monitoring Plan (PRC 1996a). A summary of monitoring well construction detail for IR-03 and vicinity is presented in Table 2-2. Groundwater flow in the A-zone is complex because of the heterogeneity of the subsurface fill materials, tidal influences, and effects of storm drain and sanitary sewer systems. Groundwater flow conditions are summarized as follows:

- The groundwater flow direction in the A-aquifer, along the south shore of IR-03, is generally inland in a northeasterly direction (Figure 2-2). The flow direction was easterly in February 1994 and November 1995, and changed to northeasterly by August 1994 (PRC 1996a). In May 1995, the direction was northeasterly as shown in Figure 2-2 (PRC 1996a). The inland groundwater flow is likely controlled regionally by the basewide utilities (storm drain and sewer systems) that are reportedly in very poor condition and may be acting as sinks. This flow direction may change in the future if the storm drain or sewer systems are modified or abandoned. Storm drain piping is located under K Street (Figure 2-1), but it is not known if or how much this piping affects groundwater flow in the IR-03 vicinity.
- Vertical gradients between the B- and A-water bearing zones are consistently upward, despite tidal fluctuations.
- Hydraulic conductivity in the A-zone at IR-03 (calculated from slug tests) ranges from 0.01 to 2 feet per day (HLA 1991a).

2.3.4.3 Tidal Influence Study

A tidal influence study was conducted in Parcel E in the vicinity of IR-03 (PRC 1994). The results indicate that tidal fluctuations in the Bay affect water levels at IR-03. The fluctuations are generally limited to areas less than 400 feet from the Bay. The report states that further inland areas are affected, but are probably related to Bay water inflow into, and leaks from broken storm drains and/or sanitary sewers into the upper aquifer. The extent of possible Bay-water infiltration through the storm drains and sanitary sewers outside of specific study regions is not known.

The results of the tidal study indicated fluctuation of the water levels at IR-03 ranging between 0.4 feet at well IRO3MW218A1 to 3.65 feet at well IRO3MW228B in March 1993 (Figure 2-1). These data indicate that IR-03 groundwater levels are strongly affected by the proximity to the Bay and the possible presence of artificial conduits. This may explain the relatively high infiltration rates reported when conducting test pit sampling during RI activities. Tidal influence data were collected during three quarterly monitoring events in 1992 and 1993.

CHAPTER 3.0
NATURE AND EXTENT OF CHEMICALS

This chapter discusses the nature and extent of chemicals found in soil and groundwater at the Site. The information is based on previous investigations that have been conducted in the IR-02 and IR-03 areas over the past decade. Hazardous substances and petroleum products are present in the vicinity of the former waste oil ponds. This removal action will use the presence of visible floating product and product-affected soils as the indicator for the extent of hazardous substances.

3.1 PREVIOUS INVESTIGATIONS

For the past ten years, an ongoing series of assessments has been conducted to investigate the former waste oil reclamation ponds. The main investigations in chronological order are as follows:

- An Initial Assessment Study (WESTEC 1984) was completed in 1984 that focused on the history and work practices at the HPA.
- Soil and groundwater sampling were first completed in 1986 when five borings were drilled and sampled (EMCON 1987). Wells IR03MW0-1 through -0-3 were installed in three of these borings.
- A series of site investigations commenced in 1989 with reconnaissance and primary phase investigations conducted as part of the OU-1 RI by HLA in 1993. These investigations included geophysical and soil gas surveys, boring and test pit installation and testing, and shallow A-zone and deeper B-zone well installation and sampling. In late 1992, contingency work was completed to provide additional information for the RI by HLA.
- In October 1995, monitoring wells IR03MW369A, -370A, and -371A were installed adjacent to the shoreline.

3.1.1 Extent of Chemicals in Soil

As discussed previously, extensive remedial investigations have been performed in the vicinity of IR-03. These activities included installing soil borings and monitoring wells, excavating test pits, sampling and analyzing soil, groundwater and free-phase product, and conducting numerous hydrogeologic testing and evaluations. The majority of this data, and all data used in the evaluation presented in this EE/CA, are included in Appendix B. The maximum and minimum values of reported chemicals in soil and free-phase product in the IR-03 vicinity are compared to site-specific HPA Ambient Levels

(HPALs) for soil, EPA Region 9 Preliminary Remediation Goals (PRGs), State of California Total Threshold Limit Concentrations (TTLCs), and Toxicity Characteristic Leaching Procedure (TCLP) levels (Table 3-1). The purpose of the comparison is to illustrate the level of non-petroleum contaminants found in the free-product and soil and are not intended as a cleanup criteria. The detection limits applicable to the various chemicals detected are presented in the "database" (Appendix B).

Figure 3-1 presents a conceptual cross-section model of subsurface conditions and the extent of petroleum-affected media at IR-03. As shown, the residual free-phase waste oil product appears to be found frequently at or above the water table in the sand and gravel portions of the fill material.

Figures 3-2 through 3-6 illustrate the approximate lateral distribution of free-phase product. The vertical extent is illustrated by successive isopleths at 5-foot depth intervals. The areal extent for each depth interval was based on soil chemical analysis as total oil and grease (TOG), visual observations of product during the RI activities and historical product thickness measurements from site monitoring wells. Sample locations where TOG concentrations exceeded 1,000 milligrams per kilogram (mg/kg) were considered representative of areas where free-phase product is likely to occur.

Figure 3-2 indicates that the extent of TOG concentrations at shallow depths of 0 to 5 feet bgs is widespread over a large area, well exceeding the IR-03 site boundaries. The exact source of this shallow TOG contamination is not known. However, it is possible that some of the TOG sources come from past surface spillage as opposed to the waste oil pond source. Overfilling and overflowing of the pond is also possible. Observations of product from soil boring log comments, occur most frequently beginning at depths as shallow as 5 feet bgs and continues to a maximum depth of 23.5 feet bgs. Generally, Figures 3-2 through 3-6 indicate that TOG concentrations exceeding 1,000 mg/kg and product observations are somewhat discontinuous over depth, however tidal influences may have effected the spread of product at IR-03.

3.1.2 Extent of Chemicals in Groundwater

This section summarizes the analytical results for groundwater samples collected at IR-03. The majority of sampling was conducted during historical RI activities between 1990 and 1992 (Appendix B). A small number of wells were sampled in 1995 and the three new wells installed near the shoreline

(IR03MW369A, -370A, and -371A) were sampled in 1996. Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), total petroleum hydrocarbons (TPHs), pesticides, and metals have been detected in groundwater samples at Site IR-03.

The criteria used to screen the detected organic and inorganic chemicals in groundwater are the water quality objectives for protection of human health and aquatic life given in the Enclosed Bay and Estuary Plan (SWRCB 1993). These screening criteria were chosen to be consistent with the approach presented for Site IR-1/21 EE/CA Groundwater Evaluation (PRC 1996b). The IR-1/21 site is also located in Parcel E, HPA, and borders on San Francisco Bay, as does IR-03.

Organic compounds were detected in groundwater samples collected from wells throughout the site. The organic chemicals detected at concentrations exceeding screening criteria presented in the Enclosed Bay and Estuary Plan (SWRCB 1993) are shown on Figure 3-7. The screening criteria are also presented on Figure 3-7. Only the detected compounds that have screening levels specified in the Enclosed Bay and Estuary Plan are shown. The most frequently detected chemicals exceeding screening levels are PAHs and Aroclor-1260. Dibenzofuran was also detected at concentrations screening criteria. No organic compounds exceeding screening criteria were detected in the wells located closest to the shoreline, in the vicinity of IR-03 (IR03MW369A, -370A, and -371A). No organic chemicals were detected in the B-zone well (IR03MW228B). The detection limits applicable to the various chemicals detected are presented in the "database" (Appendix B).

Inorganic and organic chemicals dissolved in groundwater above the screening criteria are shown in Figures 3-7 and 3-9, respectively. These figures were developed to be consistent with the IR-1/21 EE/CA technical approach but may not present all relevant data since the detection limits are higher than the low screening criteria. However, this action will use the presence of TPH compounds as the indicators for the hazardous substances and the presence of TPH compounds will be used to define the area of concern.

TPH compounds detected in groundwater and the maximum concentration detected are shown in Figure 3-8. Screening criteria for TPH in groundwater are not available. The unknown extractable TPH compounds were detected most frequently and at the highest concentrations, with a maximum of 560 milligrams per liter (mg/L) detected on the north side of IR-03 (IR03MWO-1). TPH-extractable unknown (0.051 mg/L) was detected in the B-zone well (IR03MW228B). No TPH compounds were detected in the wells located closest to the shoreline in the vicinity of IR-03 (IR03MW369A, -370A, and -371A). The reported value of 560 mg/l in groundwater (IR03MW0 1) is likely an error (petroleum product have a lower solubility) possibly due to the collection of an emulsified sample or water with free-phase product. Additionally, Figure 3-8 presents the historical measurements of floating product in the wells at IR-03.

Metals detected in groundwater at IR-03, at concentrations exceeding screening criteria include arsenic, beryllium, cadmium, copper, lead, mercury, nickel, silver, thallium, and zinc (Figure 3-9). The inorganic chemicals detected at concentrations exceeding screening criteria presented in the Enclosed Bay and Estuary Plan (SWRCB 1993) are shown on Figure 3-9. The screening criteria are also presented on Figure 3-9. Only the detected compounds that have screening levels specified in the Enclosed Bay and Estuary Plan are shown. The most frequently occurring inorganic chemicals in groundwater are copper, lead, and beryllium. No inorganic chemicals exceeding screening criteria were detected in the wells located closest to the shoreline in the vicinity of IR-03 (IR03MW369A, -370A, and -371A).

3.1.3 Characteristics of Oil

The oily waste product in IR-03 is an aged, light non-aqueous phase liquid (LNAPL) with physical characteristics similar to a used motor oil. Grab samples of the free-phase product floating on the water table have been collected from four wells in the vicinity of IR-03 and analyzed for metals, VOCs, SVOCs, PCBs/pesticides, total recoverable petroleum hydrocarbons (TRPH), TPH as diesel, density, and ignitability. The minimum and maximum concentrations of these compounds are summarized in Table 3-1 (see Appendix B). As shown, the oil contains several hazardous substances including SVOC, PCB, and metals constituents. The historically measured depths of floating product are shown on Figure 3-8.

Data from a product sample from well IR03MW371A collected in February 1996, and analyzed by Inspectorate of Martinez, California indicate that the product from the Site has an American Petroleum Institute (API) gravity of 17.9, a specific gravity of 0.95, and a vapor pressure of 3.0 pounds per square inch absolute pressure (psia). The data also indicate that less than 10 percent of the oil product has a boiling point less than 500°F. In contrast, 100 percent of gasoline, approximately 50 percent of diesel, and approximately 20 percent of Bunker C oil has a boiling point less than 500°F. These data indicate that only a small fraction of the oil has potentially significant volatility. This trait has a favorable affect on the health risk associated with inhalation pathways, but also strongly limits the ability to recover waste oil product by processes such as soil vapor extraction.

3.2 PREVIOUS OIL RECOVERY EFFORTS

An oil recovery pilot study was conducted in early 1991 to assess whether oil could be pumped from the subsurface at IR-03 under ambient conditions (HLA 1991b). This test entailed pumping four wells that initially contained over 6 inches of floating product. The wells were pumped every few weeks with a total of six pumping events over three months. Total product recovery from all of the wells was approximately 25 gallons and ranged from less than 1.2 gallons recovered from well IR03MW218A1 to 17.3 gallons from well IR03MW0-3. Results of the test indicate that removing product by pumping from wells is relatively inefficient. However, with intermittent product recovery, it may be possible to remove at least a small portion of the oil from the subsurface.

3.3 RISK CONSIDERATIONS

Streamlined Risk Evaluation

A streamlined risk evaluation was conducted to assess the potential exposures to and the health risks posed by groundwater and constituents found in the residual oil from the former waste oil reclamation ponds. The scope of evaluation is limited to providing justification for performing a removal or containment action of contaminants associated with the former oil reclamation ponds. In accordance with the EPA guidance on conducting non-time-critical removal actions, the concentrations of the identified chemicals of concern are compared to chemical-specific screening criteria (i.e., Enclosed Bay and Estuary Plan [SWRCB 1993], EPA Region 9 PRGs [residential and industrial] [EPA 1995], Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities (EPA 1994), and site-specific HPAL of metals in soil [PRC 1995a]) and when "standards for one or more contaminants in a given medium are clearly exceeded, a removal action is generally warranted, and further quantitative assessment that considers all chemicals, their potential additive effects, or additivity of multiple exposure pathways, are generally not necessary" (EPA 1993).

Risk to human health and the environment from groundwater was considered by comparing chemical concentrations dissolved in groundwater to water quality objectives for the protection of human and aquatic life found in the Enclosed Bay and Estuary Plan (Section 3.1.2). Figures 3-7 and 3-9 illustrate the distribution of exceedances of the water quality objectives for organic and inorganic chemicals respectively. For this streamlined risk evaluation, a removal action is warranted since these standards for groundwater are clearly exceeded.

Analytical data from product and soil samples collected during prior investigations were used to identify the potential chemicals of concern. For purposes of this evaluation, chemicals detected in the oil and soil samples collected in the vicinity of the former waste oil reclamation ponds are selected as potential chemicals of concern. These detected chemicals and their maximum detected concentrations are presented in Table 3-1.

HPA is presently undergoing closure and preparing the property for different land use as mandated by the Base Realignment and Closure (BRAC) Act of 1988. As part of this process, the Navy has developed a property disposal and reuse plan within the BRAC Cleanup Plan (PRC 1995A). The disposal and reuse plan includes site characteristics (e.g., nature and extent of affected areas), the Coastal Management Act, the City of San Francisco's master land use plan, the National Environmental Policy Act, community input, and CERCLA requirements. Based on these interests, the IR-03 area has been designated as having a future use as open space. The implications of the open space designation are that exposure pathways could be more easily identified and mitigation efforts (e.g., capping or isolating hazardous substances and TPH-affected soil) may be an effective strategy for protecting human health and the environment.

The results of the screening evaluation indicate that levels of chemicals in groundwater, free product, and associated soils in the area of the former oil reclamation ponds at the Site are above their respective potential chemical-specific screening criteria. Therefore, based on these elevated levels of affected materials present at the Site, a removal action for the area of the former oil reclamation ponds at the Site is justified.

CHAPTER 4.0
REMOVAL ACTION OBJECTIVES

This chapter presents the development of removal action objectives (RAOs) for the IR-03 removal action within Parcel E at HPA. This chapter also includes a discussion of the potential ARARs and criteria to be considered (TBC), that could govern this non-time-critical removal action.

4.1 STATUTORY FRAMEWORK

This removal action is taken pursuant to CERCLA and the NCP under the delegated authority of the Office of the President of the United States by Executive Order 12080 and 12580. These orders provide the Navy with authorization to conduct and finance removal actions. This removal action is non-time critical because a six month planning period was necessary before initiation of removal actions. The requirements for this EE/CA and its mandated public comment period provide opportunity for public input to the cleanup process. The entire process is also governed by Federal Facilities Agreement of January 22, 1992, which was signed by the Navy, EPA, and DTSC.

The Navy is lead agency for the removal action. As such, the Navy has final approval authority over the recommended alternative and all public participation activities. The Engineering Field Activity, West, Naval Facilities Engineering Command, is the regional manager of the Navy's CERCLA program, and is therefore providing technical expertise to conduct activities specific to the preparation of the EE/CA and the execution of the recommended alternative.

This EE/CA complies with the requirements of CERCLA, the Superfund Amendment and Reauthorization Act (SARA), NCP at 40 C.F.R., Part 300, the Defense Environmental Restoration Program at 10 U.S.C., Section 2701, et seq., and Executive Order 12580. The need for a response action at IR-03 has been evaluated in terms of the NCP removal factors from 40 C.F.R., Section 300.415(b)(2).

4.2 REMOVAL ACTION OBJECTIVES

RAOs are developed using agency directives, ARARs analysis, risk assessment data, and the nature and extent of chemical constituents. The RAOs were selected to guide the remediation by identifying goals that would, to the extent possible and reasonable, comply with ARARs and protect human health and the environment. RAOs to protect human health typically address chemical concentrations and potential exposure routes. Protection could be achieved by reducing concentrations or potential exposure. In order to protect the environment, RAOs address the medium of concern and establish target cleanup levels that protect identified environmental resources and reduce potential exposure.

However, numeric removal action goals are more appropriately applied to final remediation efforts that address all media of concern. This non-time-critical removal action is to provide efficient source cleanup or containment, in a manner consistent with future Parcel E and basewide remedial activities planned at HPA. Therefore, the following RAO has been established for the project:

- Limit potential migration of contaminants in groundwater associated with the IR-03 former waste oil ponds to the San Francisco Bay.

This RAO will protect human health and the environment and will be consistent with basewide remedial objectives and planned future remedial activities at HPA.

4.3 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

CERCLA Section 121(d)(2) states that remedial actions on CERCLA sites must attain, or justify a waiver of, any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally ARARs to site-specific affected materials, conditions, and actions. This section provides an overview of potential ARARs, and discusses the identification of ARARs and TBCs for the removal of soils and floating product from IR-03. Final ARARs would be presented in the action memorandum issued by the Navy for this removal action.

4.3.1 Overview of Potential ARARs

The identification of ARARs is site-specific and involves the following two-part analysis: (1) determining whether a given requirement is applicable and (2) if it is not applicable, whether it is both relevant and appropriate. A requirement is deemed applicable if the law or regulation specifically addresses the chemical of concern, the action, or the affected location at a CERCLA site. The requirement is applicable only if the jurisdictional prerequisites of the requirement are met (i.e., an applicable requirement that fully addresses the situation at the Site). If a law or regulation is not applicable, it may be relevant and appropriate if the circumstances are sufficiently similar to circumstances in which the law otherwise applies and if the law or regulation is well-suited to the site conditions. The criteria for determining relevance and appropriateness are listed in 40 CFR 300.400(g)(2) of the NCP. A requirement that is determined to be relevant and appropriate must be complied with to the same extent as an applicable requirement.

In addition to ARARs, the NCP provides that agency advisories, criteria, or guidance may, as appropriate, be considered as TBCs for a particular release [40 CFR Part 300.400(g)(3)]. As explained in the preamble to the NCP, TBCs should not be required as cleanup standards because they are, by definition, generally neither promulgated nor enforceable so they do not have the same status under CERCLA as do ARARs. TBCs may, however, be useful in helping to determine what is protective at a site, or how to carry out certain actions or requirements. CERCLA Section 121(e) exempts on-site actions from having to obtain federal, state, or local permits. However the substantive portions of the permits are required. Off-site actions must comply only with requirements that are legally applicable, as well as with the administrative parts of those requirements.

CERCLA Section 121 (d)(4) provides that, under certain circumstances, an otherwise applicable or relevant and appropriate requirements may be waived. These waivers apply only to the attainment of the ARAR. Other statutory requirements, such as the chosen remedy being protective of human health and the environment, could not be waived.

4.3.2 Identification of ARARs and TBCs

ARARs are generally divided into three categories: chemical-, location-, and action-specific. The sections below present federal and state ARARs that are potentially applicable to the removal action at IR-03. TBCs are presented following a discussion of ARARs.

4.3.2.1 Potential Chemical-Specific ARARs

Chemical-specific ARARs are generally health- or risk-based numerical values or methodologies applied to site-specific conditions that result in determination of waste classification or the establishment of numerical cleanup values.

No health- or risk-based numerical cleanup values for soil or free-phase petroleum products have been promulgated by EPA or the State of California. The scope of this removal action does not include groundwater or adjacent surface-water treatment or restoration; rather the action is for containment only. Therefore, it is beyond the scope of this removal action to identify chemical-specific ARARs relating to water. ARARs for surface water and groundwater (e.g., the Safe Drinking Water Act) will be considered in other HPA feasibility studies and related CERCLA documents for groundwater concerns within Parcel E as a whole. Therefore, there are no chemical-specific ARARs identified for this removal action.

4.3.2.2 Potential Location-Specific ARARs

Location-specific ARARs restrict actions or affected concentrations in certain environmentally sensitive areas. These requirements may limit the type of removal action that could be implemented, and may impose additional constraints on cleanup levels. Examples of environmentally sensitive locations include wetlands, coastal zones, and areas or buildings of archaeological or historical significance. The existence of endangered or threatened species within the area must also be considered.

No historical buildings or architectural, archaeological, or cultural resources exist within Parcel E (HPA BRAC Cleanup Plan). Therefore, ARARs such as the Antiquity Act or Archaeological Resources Protection Act were not included as potential ARARs.

Three potential ARARs were identified as potentially applicable to the removal action and have been included within Table 4-1. The Protection of Wetlands Executive Order 11990 was included as an ARAR because of the presence of designated wetland areas known to exist within Parcel E. The two nearest wetland areas to IR-03 are located approximately 1,200 feet to the southeast and northwest of the Site. However, removal activities are not planned for these areas. Removal activities would be specifically designed to avoid these areas in the future.

Since IR-03 is located in a coastal zone with intertidal mud flats directly adjacent to the Site, the Coastal Zone Management Act and California Coastal Act have been included as ARARs. However, removal activities would be restricted to inland areas with engineering controls used to prevent both water and airborne spread of site-affected materials to coastal areas and intertidal mudflats. Section 30232 of the California Coastal Act specifically allows for "effective cleanup facilities" to address affected sites with hazardous and petroleum wastes and to prevent spills of such waste during transportation activities. Removal activities would be designed to limit the possibility of spills of product or product-affected soils, provide facilities for effective cleanup should such a spill occur, and in general, remove of effectively contain product and product-affected soils.

The HPA BRAC Cleanup Plan identifies seven threatened and endangered species within the HPA boundaries including two species of salt water fish and five bird species. For this reason, the Endangered Species Act has been included as a federal ARAR. Additionally, the BRAC Cleanup Plan has identified 21 species of animals listed as California special animals and 2 species of plants listed as California special plants. For this reason, the California Endangered Species Act has also been included as a state ARAR. However, removal activities would be restricted to inland areas with engineering controls used to prevent the spread of both water- and airborne-affected materials to effected animal or plant species. Completion operations at the Site would return any excavated areas to pre-existing conditions and re-seeding would include consideration for listed California plants. Disturbance of any endangered species or their habitats is unlikely during removal activities.

4.3.2.3 Potential Action-Specific ARARs

Action-specific ARARs should be tailored to the on-site activities that are part of the selected removal action alternative. Action-specific ARARs do not determine the remedial alternative; rather, they indicate how to a select an alternative. These regulations define the performance, design, or other similar action-specific controls or restrictions on activities related to the management of hazardous substances. Because action-specific ARARs depend on the remedial action selected, they are best identified following the initial screening of remedial alternatives. Table 4-2 presents potential action-specific ARARs. The following is a general discussion of the action-specific ARARs. After selection of a removal action remediation alternative, the action-specific ARARs should be reviewed for applicability to the selected remediation.

Many Resource Conservation and Recovery Act (RCRA) requirements are applicable or relevant and appropriate to the remedial alternatives selected in this EE/CA. RCRA may be delegated to a state program if the state statutes and regulations are equivalent to or more stringent than the federal statutes and regulations. California is authorized to manage the "base" program (i.e., the requirements in existence before the passage of Hazardous and Solid Waste Amendments [HSWA] in 1984). The EPA enforces the requirements promulgated pursuant to HSWA. Therefore, in some cases, the applicable or relevant and appropriate RCRA requirement listed would be cited as a state or federal law or both.

RCRA provides comprehensive regulations for the transfer, treatment, storage, and disposal of RCRA-defined wastes. Based on historical as well as future sampling of potentially affected soils and free-phase product, a determination of whether these materials meet the definition of a RCRA hazardous waste or non-RCRA hazardous waste would be made. The federal chemical-specific ARAR, 40 CFR Part 261 or 22 CCR Division 4.5 Chapter 11 (state-authorized RCRA program) would determine whether soils and product must be managed as a RCRA hazardous waste.

The proposed remedial alternatives at IR-03 involve excavation, storage, and off-site disposal of wastes. If a remedial alternative involves RCRA wastes (or waste that is sufficiently similar), then substantive requirements within 22 CCR, Division 4.5 that apply to generators of hazardous waste are potential ARARs. For example, Chapter 12 contains provisions regulating record keeping and exporting of such wastes off site.

Similar to RCRA, several Clean Air Act (CAA) regulations are applicable or relevant and appropriate to the remedial alternatives presented in this EE/CA. The CAA is a state-delegated program within California. Potential action specific ARARs are found within California's State Implementation Plan (SIP). The local Bay Area Air Quality Management District (BAAQMD) has established requirements for excavating, aerating, and stockpiling soils affected with VOCs. Additionally, the BAAQMD sets requirements for fugitive dust generated from construction sites. These requirements apply to removal activities proposed at IR-03 for soil excavation or stockpiling activities.

4.3.2.4 Other TBCs

There are numerous federal and state TBCs which would apply to affected soils and free-phase petroleum products and the remedial activities proposed for IR-03.

The Toxic Substances Control Act (TSCA) PCB Spill Cleanup Policy is included as a TBC because of the presence of PCB at a maximum level of 12 parts per million (ppm) in soil. This policy applies to PCB spills of 50 ppm or greater. The concentration of PCBs spilled is determined by in the material onto which the PCBs were spilled. Where a spill of untested mineral oil occurs, the oil is presumed to contain greater than 50 ppm, but less than 500 ppm PCBs, and is subject to the relevant requirements of this policy. The policy requires cleanup of PCB spills occurring after 1987 to residential levels of 1 ppm and between 10 to 25 ppm for industrial-zoned uses. It is unlikely that any waste oils containing PCB concentrations were released at the Site after 1987 since the impoundments were backfilled in 1974, however, this policy is included as an additional TBC.

Additionally, the California Leaking Underground Fuel Tank (LUFT) Manual, revised in October 1989, is a TBC because it provides guidance to determine cleanup goals for gasoline and diesel contaminated soils. The LUFT Manual and its application have received consideration through the Senate Bill 1764 LUFT Advisory Committee. This committee advised that the LUFT Manual be revised to rely more heavily on natural process remediation, and to use risk-based analysis for selection of appropriate remedial goals. A recent report from the Lawrence Livermore National Laboratory (LLNL) entitled, "Recommendations to Improve the Cleanup Process for California's Leaking Underground Fuel Tanks" (October 16, 1995) has also addressed this issue. The Director of the State Water Resources Control Board (SWRCB) has concurred with the findings of the recent LLNL report. For this reason the directive from the SWRCB, dated December 8, 1995, has been included as an additional TBC.

4.3.2.5 Other Requirements to be Followed

The Occupational Safety and Health Act (OSHA; 29 CFR 1910.120) is an additional, non-environmental related requirement to be followed. OSHA regulates exposure of workers to a variety of chemicals in the work place, and specifies training programs, health and environmental monitoring, worker personal protection, and emergency procedures to be implemented.

CHAPTER 5.0
POTENTIAL REMOVAL ACTION REMEDIAL TECHNOLOGIES

This chapter reviews a number of remedial technology process options that may be applicable to the IR-03 removal action. The process option technologies are presented in Table 5-1. These options are generally described and screened in the following sections so that only the most applicable process options are evaluated further.

The ineffective or not applicable technologies are screened out, primarily based on the criterion of technical implementability, and the ability to address the types of affected materials found at the Site. The retained process options are evaluated in detail in Sections 6.1 through 6.6 then combined into alternatives for a comparative analysis in Chapter 7.0.

5.1 INSTITUTIONAL CONTROLS

Institutional controls include deed restrictions, deed notificaiton, or access restrictions. These controls may be used to minimize exposures to humans and the environment by prohibiting groundwater use and/or certain types of future land use. Currently, Site IR-03 is fenced and no public access if allowed. This will continue throughout the removal action and the RI/FS process.

Access restrictions will be retained for use in conjunction with other process options as a precaution to ensure that the public (especially nearby workers) will not be exposed to hazardous substances.

5.2 REMOVAL OPTIONS

Removal process options include soil excavation, groundwater extraction, and the extraction of product. Removal options are included because soil saturated with waste oil and floating product on groundwater act as a source to groundwater. If the source of chemicals to groundwater is eliminated, then meeting the RAO of limiting migration of affected groundwater is made easier.

5.2.1 Excavation of Soils

This option consists of removing soils from selected areas using a backhoe, scraper, dragline, or other conventional earth-moving equipment. Following excavation, soils would need to be stockpiled and segregated into soils requiring treatment or no further remediation.

The advantages of this process are:

- Chemically affected soil is removed.
- Excavation provides access to free-phase product which could be removed from the excavation more readily than from wells or trenches.
- Future land use need not be limited.

The disadvantages of this process are:

- The excavated soils may need to be drained, dewatered, and stockpiled.
- It may be difficult to excavate below the water surface; expensive shoring and water-control measures such as dewatering and water treatment may be required. Drag-line excavation techniques may be used for soils below the water table, however, observation of visible product in soil would not be possible.
- Excavation would be complicated by subsurface obstructions and the heterogeneous subsurface soils.
- Monitoring wells would have to be abandoned or protected before excavation of the soil.

Soil excavation is retained for further consideration.

5.2.2 Groundwater Extraction

This option consists of removing groundwater using wells, collection trenches or subsurface drains. Water is pumped from the subsurface through piping to an aboveground process system. Following collection, the groundwater is generally treated to meet disposal criteria.

The advantages of this process are:

- Collects dissolved contaminants.

- Enhances the local groundwater gradient.
- Provides or enhances migration control.

The disadvantages of this process are:

- Requires complex pumping and treatment system.
- Involves complicated groundwater collection because of presence of floating product.
- Requires costly groundwater treatment and disposal.

Groundwater extraction will not be retained for further consideration for this removal action. Groundwater pumping was considered to enhance containment with the sheet piling subsurface barrier. However, the Navy feels it prudent to proceed with the installation of the sheet pile wall and not include groundwater pumping at this time because the current flow direction is inland. The Navy proposes to act in a conservative manner to protect the Bay by placing the wall between the waste oil ponds and the Bay. The potential does exist for groundwater to build up behind this wall and flow around the extreme edges of the wall once the flow direction changes. However, it is anticipated that a large change in flow direction toward the Bay will be primarily due to the Navy's actions to reduce groundwater sinks during final remediation. The final remedial action will consider the effect the new flow direction will have on the sheet pile wall performance in protecting the Bay. Once the final action is determined, it may be prudent to install a groundwater gradient control system (pumping system) on the inland side of the wall to eliminate potential flow around the wall.

5.2.3 Product Extraction

Two product extraction options have been identified including product extraction from wells or trenches and product extraction from open excavations following excavation of soils to the water table.

5.2.3.1 Product Extraction From Wells or Trenches

This process option involves product recovery from wells or trenches on site by pumping or skimming. Existing wells would be used or new wells or trenches would be constructed at locations of known free product, and pumped or skimmed repeatedly, using a product skimmer, bailers, total fluids pumps, or a vacuum truck. The reclaimed product would be recycled off site.

A pilot study product recovery investigation was performed at IR-03 using existing wells (Section 3.2) (HLA 1991b) with limited results. This process could be enhanced, as compared to the pilot study, through the installation of new larger diameter wells or rock-filled trenches, with an optimized pumping schedule, or by conducting dual-phase pumping which would draw down the water table, encouraging free-phase product flow to the extraction wells. However, because of the apparent immobility of LNAPL in this subsurface system, only a small fraction of the product present is anticipated to be removed in this manner. Consequently, due to constructability issues relating to the trenching and low effectiveness of product extraction from wells, this process option is not retained for further consideration.

5.2.3.2 Product Extraction from Open Excavation

This process option involves recovery of floating product from an open excavation following soils removal to just below the water table level. Product would be removed using a skimming system. Product would be pumped to temporary oil storage drums or tanks equipped with high level shutoffs. The recovered product would be recycled off site. This option uses standard pumping equipment and is considered very implementable. This option would remove visible floating product which accumulates in the open excavation. It is anticipated that this is the most effective product removal approach since removal of soils above the groundwater table allows an excellent collection surface and the unimpeded buoyancy of the oil will assist collection.

This process option is retained for further consideration and will be combined with the excavation process options.

5.3 PHYSICAL BARRIER CONTROL OPTIONS

Physical barriers (e.g., slurry walls or sheet piling subsurface barriers) have been used effectively to isolate chemically affected soil and prevent LNAPL migration. However, these technology options do not reduce the toxicity or volume of the affected areas, and it is possible for physical barriers to degrade over time.

5.3.1 Slurry Wall

This process option involves excavating a vertical trench which is filled with a slurry. The slurry, usually a mixture of bentonite soil and water, hydraulically shores the trench to prevent collapse during installation, and also forms a low permeability barrier to reduce LNAPL and groundwater flow. The nature of the excavation is a narrow (2 to 5 feet wide) trench completed to the required depth with walls supported by slurry.

The advantages of this process are:

- The chemically-affected soil is isolated and LNAPL mobility is reduced.
- The slurry wall provides low permeability barrier.

The disadvantages of this process are:

- Corrosion of sheet piling.
- The product source is not removed.
- Future land use would probably be restricted.
- Instability and collapse of trench walls may be a problem in the heterogeneous fill soils at IR-03. Previous attempts at slurry wall installation in the HPA Parcel E indicate that subsurface materials are so loose that the slurry alone could not keep the trench from caving. Additionally, encountering subsurface obstructions made trench installation very difficult.

This process option is not retained for further consideration because of slurry wall installation problems described above.

5.3.2 Sheet Piling

Sheet piling subsurface barriers may be driven into the subsurface around the limits of the LNAPL-affected soil, to isolate it and prevent LNAPL migration. The sheet piling subsurface barriers consist of long, thin, interlocking sheets of steel, driven vertically into the soil to form a barrier.

The advantages of the process are:

- The chemically affected soil is isolated and LNAPL mobility is reduced.
- The sheet piling subsurface barrier provides a structural barrier that, with anchoring and tie-backs, may also be used as shoring during excavation activities.
- No open excavation or trenching is required.
- Cost effectiveness.

The disadvantages of the process are:

- The product source is not removed.
- Future land use would probably be restricted.
- The joints between the steel sheeting may need to be grouted to obtain water tightness which may be problematic.
- Subsurface obstructions may make the driving of piles difficult.

This process option is retained for further consideration as representative of physical barriers, since it is cost effective and may be easier to install than a slurry wall or a grout curtain.

5.3.3 Grout Curtain

This process option involves drilling boreholes with multiple augers, injecting grout, and mixing the grout with the soil, through the rotary action of the augers. Two to four augers could be used together to aid in mixing. The process is repeated in a linear fashion to form a low permeability barrier wall.

The advantages of this process are:

- The chemically affected soil is isolated and LNAPL mobility is reduced.
- No open excavation or trenching is required.

The disadvantages of this process are:

- The product source is not removed.
- Future land use would probably be restricted.
- Subsurface obstructions could cause installation problems.
- Cost effectiveness.

This process option is as effective as other barriers yet is not retained for further consideration because installation could be difficult because the heterogeneous nature of the backfill may cause grout loss.

5.4 EX SITU PHYSICAL/CHEMICAL TREATMENT

5.4.1 Soil Washing/Thermal Desorption/Chemical Oxidation/Stabilization

Ex situ treatment processes include processes such as soil washing, thermal desorption, chemical oxidation, and soil stabilization. These processes either remove chemicals of concern from the affected media or, in the case of stabilization, isolate and immobilize the chemicals of concern. Ex situ processes require excavation of the soil before treatment. If treatment is conducted on site, the treated soil would be replaced on site as fill material. It is not cost-effective to treat soil on site and then incur the cost to dispose off site at an approved disposal facility and purchase clean backfill.

Ex situ treatment of soils can be effective in reducing contaminant levels, but will not be retained for further consideration because it requires a long lead time, which is unacceptable for the removal action relative to the RI/FS process. Additionally, treatment space is limited on HPA and extensive staging of the soil treatment is required. This extends the treatment operation sampling and backfill schedule and would require the excavation to remain open while the soil was verified as acceptable. However, given the instability of the excavation walls, the excavation should be backfilled as quickly as possible. The applicability and cost-effectiveness of ex situ treatment can be favorable given less constraints on schedule and space requirements and should be considered in the Parcel E FS.

For these reasons ex-situ soil treatment is not retained for further consideration.

5.4.2 Oil/Water Separation

This process is based on separating liquid phases based on density and specific gravity differences. In a mixture of a LNAPL and water, the LNAPL is the less dense fluid and will rise to the top of the water, given a calm environment. This could be accomplished in tanks or lagoons, or would occur naturally in the exposed groundwater surface during excavation. The product layer is then removed from the top of the water layer and recycled off site.

Oil/water separation is an important step for many other process options since it removes large amounts of product, thereby reducing the cost of other options. Emulsified or dissolved product concentrations would not be removed with this process.

This process option is retained for further consideration.

5.5 BIOLOGICAL TREATMENT

Biological treatment process options utilize microbial organisms to metabolize affected materials to nontoxic compounds, carbon dioxide, and water. Biological treatment may be performed in situ or ex situ, and usually requires the addition of oxygen, nutrients, or microbes to the treated medium.

5.5.1 Soil Bioremediation

With this process, nutrients are added to stockpiled soil to enhance biodegradation by existing organisms. The soil is periodically aerated by tilling or discing with conventional earthmoving equipment.

The advantages of this process are:

- Treatment results in permanent removal of some product from affected soil.
- The process requires little supervision and most of the personnel require little training.

The disadvantages of this process are:

- This process has lower removal efficiencies than some other treatment process options such as thermal desorption.
- Air emission controls may have to be implemented.
- Bioremediation would take a relatively long time to achieve reduction of TPH concentrations. The amount of chemical reduction may not be enough to allow replacement of treated material. For example, the biodegradation treatability study work plan (PRC/ECOVA 1995) indicated that soil bioremediation could reduce LNAPL concentrations by at least 20 percent, but that "successful biodegradation" may only reduce TPH concentrations to 1,000 mg/kg.

This process option is not retained for further consideration because of the extended treatment duration and because it may not reduce chemical concentrations sufficiently.

5.5.2 In Situ Bioremediation

The activity of naturally occurring microbes is enhanced by circulating water-based nutrients, oxygen, or other amendment solutions through product-affected soils to stimulate in situ biological degradation.

The advantages of this process are:

- Excavation is not required.
- The treatment results in permanent destruction of affected materials.
- VOCs and SVOCs concentrations in groundwater could also be reduced.

The disadvantages of this process are:

- A system for introducing and circulating nutrients and oxygen is required.
- In situ technologies require relatively uniform subsurface conditions and relatively high permeabilities. The subsurface heterogeneity at IR-03 may reduce the process effectiveness in some areas.
- The process would take a relatively long time to attain cleanup goals.
- Extensive monitoring would be required to ensure that hydraulic control is maintained and to verify process effectiveness.

This process is not retained for further consideration because of the above process disadvantages. Additionally, the biodegradation treatability work plan (PRC/ECOVA 1995) also rejected in situ biodegradation as a viable treatment option for IR-03.

5.6 IN SITU PHYSICAL/CHEMICAL TREATMENT

In situ physical/chemical methods do not require excavation of soils, thus eliminating soil handling issues. However, these methods require relatively homogeneous subsurface soil conditions and relatively high soil permeabilities for treatment effectiveness.

5.6.1 Bioventing/Air Sparging/Soil Vapor Extraction

These processes use the basic principle of inducing air flow in the subsurface, through air injection and/or vacuum, to increase intrinsic biodegradation. An applied vacuum may be used to enhance volatilization of organic compounds.

The advantages of these options are:

- Excavation is not required.
- They are highly effective in removing VOCs.

The disadvantages of these options are:

- They are less efficient in addressing SVOCs, nonVOCs, or large volumes free-phase product.
- They may be difficult to control in a heterogeneous subsurface environment.
- The processes may take a relatively long time to reduce chemicals concentrations sufficiently.
- Extensive monitoring would be required to verify process effectiveness.

These options are not applicable to IR-03, because of the subsurface heterogeneity and the physical characteristics of the product, and will not be considered further.

5.6.2 Thermally/Chemically Augmented Product Recovery

Thermally and chemically augmented product recovery involves injection of hot water or steam, or a surfactant-containing solution, into the subsurface through injection wells and withdrawal of groundwater and product from surrounding extraction wells. The in situ heating causes a drop in the product's viscosity, thus causing it to flow more readily under an applied hydraulic gradient. Injected surfactants increase the mobility of product by decreasing oil/water interfacial tension. A treatability study work plan has been prepared for studying the feasibility of thermally and chemically augmented LNAPL recovery at IR-03 (HLA 1993).

The advantages of this process are:

- Product is removed from soil.
- Excavation is not required.

The disadvantages of this process are:

- An injection/extraction well system is required.
- The process needs uniform subsurface conditions and relatively high permeabilities; the subsurface heterogeneity at IR-03 may reduce the process effectiveness or make the product movement hard to control in some areas.
- The heat source may be costly.
- The process generates a large volume of extracted water and/or treatment solution that would subsequently require treatment and discharge.
- Extensive monitoring would be required to ensure that hydraulic control is maintained and to verify process effectiveness.

A pilot study for thermally and chemically augmented product recovery was proposed, but not conducted because of the high expected cost and problems with soil heterogeneity. This process option is not considered further because of the process disadvantages.

5.7 DISPOSAL

Disposal options for excavated soil and recovered product are presented below.

5.7.1 Off-Site Soil Disposal

This process option involves sampling and transporting excavated soil by truck to a licensed disposal facility. Analysis of product-affected soils at the Site indicates that they would probably be acceptable for Class II landfill disposal. The closest Class II disposal facility is 55 miles from HPA. The soil must pass a waste approval process and comply with state and federal regulations before being accepted by the landfill.

This option would permanently reduce the volume of contamination at IR-03, and is retained for further consideration.

5.7.2 Product Recycling

Recycling of the recovered product is performed by licensed recycling facilities. The product would be collected into vacuum tanker trucks, sampled, and transported to a recycling facility. This process option would be effective in recycling product removed from extraction wells or open excavations at the Site. The product may be accepted at a nonhazardous oil recycling facility, pending testing of the recovered product. The closest facility that may be used is approximately 20 miles from HPA. If the recovered product does not meet the nonhazardous criteria, it could be disposed of at a hazardous waste recycling facility. The single hazardous waste facility within the State of California is located approximately 400 miles from HPA in Compton, California.

This option would be effective in reducing the volume of product at IR-03. This process option is retained for further consideration for use in conjunction with other process options.

5.8 RESTORATION OPTIONS

Restoration options for the excavation are described below.

5.8.1 Backfill with Excavated Unaffected Overburden

With this process option, excavated overburden not requiring treatment would be replaced and compacted in the excavation. Crushed rock or pea gravel would be placed in excavated areas below the water level so that mechanical compaction is not required. Topsoil would be placed on top of the replaced overburden and seeded with native grass to minimize dust generation and for erosion control.

The advantages of this process are:

- It avoids costly soil disposal and replacement.
- It replaces original material in excavation.

The disadvantages of this process are:

- This option does not address ambient metals that may be present in the untreated overburden.

This option is retained for further consideration.

5.8.2 Backfill with New Fill Only

With this process option clean new fill would be brought on site and placed and compacted in the excavation. Crushed rock or pea gravel would be placed in excavated areas below the water level so that mechanical compaction is not required. Topsoil would be placed on top of the replaced overburden or treated soil and seeded with native grass to minimize dust generation and for erosion control.

The nearest quarry is located approximately 10 miles away from HPA.

The advantages of this process are:

- New fill would have lower metals concentrations than untreated overburden soil.

The disadvantages of this process are:

- Imported fill may be relatively costly to buy and transport.
- Excavated soil would require disposal.

This option will be retained for further consideration.

CHAPTER 6.0

DETAILED ANALYSIS OF REMOVAL ACTION TECHNOLOGIES

This chapter presents a detailed evaluation of the technology options selected to address hazardous substances and oily waste at IR-03. These options are evaluated on the basis of effectiveness, implementability, and cost. As described in the EPA guidance on conducting non-time-critical removal actions (EPA 1993), effectiveness, implementability, and cost encompass the following aspects:

- **Effectiveness** - Addresses the objectives of the removal action and considers the protection of public health and the environment, compliance with ARARs, the short- and long-term effectiveness and permanence, and the potential for reduction of the toxicity, mobility, or volume of chemicals through the technology process option.
- **Implementability** - Addresses the technical and administrative feasibility of the technology, as well as the availability of equipment and services necessary for implementing the technology.
- **Cost** - Includes estimates of the direct, indirect, and operation and maintenance costs.

6.1 INTRODUCTION

Technologies from the four general response categories of removal, control, disposal and restoration, are discussed in this section. Based on the review and screening of technologies in Chapter 5.0, the removal technologies retained for further evaluation are excavation of soil and product collection from the open excavation. The viable technology considered for the control action is the construction of a subsurface sheet pile barrier to reduce potential migration of chemicals to the Bay. Off-site soil disposal to a state-approved facility and product recycling are the two retained disposal technologies evaluated in this section. The two technologies retained for the restoration action are replacement of overburden soils (soils excavated and verified as acceptable for backfill), and placement of imported clean fill.

Preliminary costs are based on estimated volumes of affected soils, field conditions, and other remedial component features. While these estimates should be considered preliminary, they are useful in developing initial cost estimates and in comparing relative costs between remedial options. Final cost estimates of a selected alternative will be prepared after completion of pre-installation investigation and after detailed design of the selected alternative components.

Cost estimates are based on general construction cost data guides, previous engineering experience, and vendor and contractor estimates. Indirect costs were estimated as a percentage of direct costs. Engineering design and planning, as well as construction or inspection, management and testing were estimated as 10 percent for direct costs less than one million dollars and as 8 percent for direct costs greater than one million dollars for technology options requiring significant engineering, planning, or construction management. For those less complex technology options with less engineering, planning or construction management requirements, costs were estimated as 5 percent of direct costs. Health and safety plan preparation and monitoring costs were estimated as 2 percent of direct costs and permitting costs were estimated as 5 percent of direct costs. In addition, a 20 percent direct contingency has been added to each estimate.

The technologies within each general response action are described and evaluated in detail in the following sections. Tables 6-1 and 6-2 summarize this evaluation of the technology options for their respective effectiveness, implementability, and cost. In Chapter 7.0, these options are combined to develop viable, cost-effective removal action alternatives.

6.2 REMOVAL OPTIONS

The removal response actions consist of (1) removal of overburden and product-affected soil by excavating soil to the water table, (2) excavation of soil below the water table, and (3) removal of free-phase product by skimming from the water surface in the open excavation.

6.2.1 Excavate to Water Table

6.2.1.1 Description

This removal option consists of the following activities:

- Pre-excavation soil sampling from ground surface to the water table. Pre-excavation sampling verifies the lateral and vertical extent of soils to be removed. Analytical results of such sampling with TPH or TOG concentrations greater than 1,000 mg/kg will be assumed as indicative of product affected soils to be included within the limits of excavation.

- Excavation of product-affected soils containing hazardous substances and free-phase product using hydraulic backhoes or scrapers to just below the water table (approximately 11 feet bgs). Excavations would be sloped, where feasible, to avoid the need for shoring. However, shoring may be required to keep excavations open adjacent to the existing shoreline riprap embankment or in areas where excessive fill material sloughing occurs.
- Physical segregation of soils during excavation based on visible product or product staining. Stockpiling of soils on 60-mil plastic liner with provisions for runoff toward a collection sump and an oil/water separator tank.
- Segregation of soils following composite sampling. Final characterization soil sampling from excavation sidewalls to verify the concentrations of TPH, TOG, PCBs, and metals in the soils remaining. Additional excavations shall be performed, if necessary, until soil sampling indicates that the majority of the free-phase product has been removed.
- Extraction of floating product from open excavations using a top loading skimming system.

Based on boring log information and previous soil sampling at the Site, contours showing the limits of free-phase product in soils were developed for 5-foot depth intervals (see Figures 3-2 through 3-6). The estimated volume of soil to be excavated from 0 to 11 feet bgs is approximately 54,000 cubic yards or 78,500 tons (assuming a density of 1.45 tons per cubic yard). This volume was developed assuming that the limits of the excavation, shown on Figure 6-1, are appropriate for soil excavated to 11 feet bgs. Subsequent disposal options assume that 50 percent of this material will require off-site disposal based on reviews of available analytical results.

Pre-excavation soil sampling is proposed to collect samples from ground surface to the existing water table depths according to a systematic grid sampling approach. Soil samples will be analyzed for TPH, TOG, PCBs and metals. The extent of soil to be excavated will be based primarily on visible evidence of free-phase product and results of pre-excavation sampling. Analytical results from pre-excavation sampling which indicate TPH or TOG concentrations greater than 1,000 mg/kg will be assumed as indicative of product-affected soils to be included within the limits of excavation. If the field data indicate that the actual limits will exceed the original limits, shown in Figure 6-1, by more than approximately 10 percent, the regulatory agencies and the Navy will be contacted to assess the new conditions. Soil sampling protocols and methods will be presented in the Removal Action Work Plan.

Before excavation, seven shallow A-zone monitoring wells will require abandonment using grouting techniques. Four existing deeper B-zone wells located at the site boundaries will be protected for future use. Three existing A-zone wells could be entirely removed (grouting not required) during excavation. The only known underground utility at this location is a sewer/storm drain line running underneath and parallel to "K" Street; however, the Navy will be consulted for locating utilities before excavation begins.

Given the heterogeneous nature of the fill materials being excavated, large debris (i.e., wood, rocks, concrete) will require physical separation and stockpiling separately from soils. As specified in the Removal Action Work Plan, soils containing visible free product will also be physically separated and stockpiled separately from soils with no visible product. Side sloping the upper 5 feet of excavation at a 1.5:1 slope (run/rise) will be necessary as site soils are categorized as a Type C or lower OSHA soil. Sloping the excavation will avoid the need for shoring at depths greater than 5 feet. Temporary shoring will be difficult given the likelihood of encountering subsurface obstructions. However, it may be necessary to shore areas of excessive material sloughing or adjacent to the Bay since side sloping will not be feasible there. Shoring, if necessary will consist of sheet piling (see Section 6.3.1.1). Panel excavation may be a cost-effective alternative to sheet piling, however, sheet piling has been assumed for cost estimating purposes since this removal option is combined with the sheet piling control option in Chapter 7.0 as Alternative 3. Further evaluation of the engineering design and shoring methodology will be evaluated in the Removal Action Work Plan.

For a 78,500-ton quantity of stockpiled soils, an estimated 7-acre storage area will be required for temporary soil storage, sampling, and segregation. This estimate assumes that scrapers will be used to stockpile soils in trapezoidal windrows (300 feet long, 20 feet wide at the base, and 8 feet wide at the top). While such a large area is not available directly adjacent to the Site, a 3.4-acre rectangular area located just east of the Site between "K" and "J" Streets could be used for these purposes (see Figure 6-1). Additionally, a 1.25-acre asphalt paved lot is vacant and accessible for material storage purposes approximately 500 feet to the northwest of the Site. Staging of the excavation activities will be necessary to accommodate the limited storage area.

Stockpiling of soils will require placement of a 60-mil plastic sheeting as well as berming along the boundary of the area for drainage control. Soils removed from near the water table will have the highest moisture content and may contain free fluids. These soils will be stockpiled in the lined area directly east of the excavation. The lined stockpile area will be sloped to a sump area, where free fluids will be collected. Fluids will be routed through an oil/water separator and then flow by gravity back into the excavation. During rainy weather, stockpiled soil will be covered with plastic sheeting to minimize infiltration of rainwater into stockpiled soils. Runoff would be directed away from stockpiled soil areas.

After soils are excavated to or just below the water table, free-phase product should begin to pool on the water surface in the excavation. The estimated volume of floating product is 40,000 gallons, based on product thickness measurements from site monitoring wells and considerations of existing soil porosity and residual soil saturation levels for a fuel oil. This product will be removed using a skimming system or a top loading pumping system. Product will be pumped to temporary oil storage drums or tanks. Product and air hoses will be of industrial grade material compatible with the pressures and chemical constituents that will be encountered. The oil storage tank will be vented and equipped with a high level shutoff. Product will be removed from the tank by a vacuum truck for off-site recycling as described in Section 6.5.2.

Decontamination facilities for equipment and personnel will be provided from two existing decontamination areas located approximately 500 feet to the northwest of the Site. In accordance with current procedures, wastewaters generated from the decontamination facility will be sampled and if acceptable, disposed of within the wastewater collection system operated by the City of San Francisco. Wastewaters failing to meet the disposal requirements will require treatment and/or off-site disposal at an appropriate permitted facility. On-site treatment of the decontamination facility could consist of oil/water separation followed by passing water though one or two canisters of granular activated carbon.

6.2.1.2 Effectiveness

This option will remove a large portion of the product-affected soils and free-phase product floating on the water table. However, product saturated soils existing below the water table will be left in place at depths greater than about 11 feet bgs. The overall potential risk to human health will be greatly reduced through the shallow soil removal. The predicted future land-use as an open space area will be accommodated by this option since soil removal will effectively limit or minimize the chance for human contact with product-affected soil over the long term. Protection of the environment is limited since a majority, but not all of the product is removed. Groundwater quality, and thus the potential threat to the Bay, will continue to be compromised from free-phase product in saturated soil deeper than 11 feet bgs. Natural attenuation processes will reduce the product volume over time. A reduction in volume and mobility is achieved to the degree that a significant portion of the contaminant will be removed. The toxicity of product remaining in saturated soils will not be reduced. It is expected that this option will comply and can be conducted in accordance with ARARs identified in Chapter 4.0. For these reasons, the remedial action objectives are achieved to a substantial degree and the long-term effectiveness is considered to be good for this option.

The short-term effectiveness is considered excellent for this option. Protection of the community and workers will be easily provided through standard environmental engineering controls and practices. On-site workers will be protected from site hazards through implementation of a site-specific health and safety plan. Removal operations would be controlled to comply with federal and state air quality and RCRA waste handling requirements. This option can be completed in a timely manner in comparison with other options.

6.2.1.3 Implementability

The reliability of this option is considered excellent since it involves traditional excavation and stockpiling methods. Operational difficulties exist with shoring in heterogeneous fill. Construction practices will have to meet applicable air quality and health and safety standards, but these are not considered unusual for this type of work. Staging of the work will be necessary because of stockpiling storage constraints, but it is not expected to significantly affect the time schedule to completion. Overall, the technical feasibility of this option is considered to be good.

There are no requirements for easements or right-of-way and zoning variances to perform this work because the Site is federal property. The City of San Francisco may require an application for a permit to discharge any wastewater to the wastewater treatment system. Notification to the BAAQMD is recommended to demonstrate compliance with air quality ARARs such as those for fugitive dust and uncontrolled VOC emissions, however, there are no administrative permit requirements necessary from this agency. Overall, the administrative feasibility for this option is considered very good.

6.2.1.4 Cost

Table A-1 presents the estimated costs for excavating soil to the water table. Total direct and indirect costs have been developed from recent contractor and vendor estimates. The total estimated cost for this option (excavate to water table) as reflected in Table A-1 is $782,000.

The following conditions during removal activities could significantly affect cost:

- Sloped or benched soils may be too soft to support heavy equipment.
- The presence of large boulders or other debris may complicate excavation.
- Subsurface obstructions may complicate shoring installation.
- Product-affected soil and free-phase product volumes may vary significantly from estimated volumes.

6.2.2 Excavation Below the Water Table

6.2.2.1 Description

This removal option will require excavation of soils to the water table (Section 6.2.1) in conjunction with the following activities:

- Pre-excavation soil sampling from the water table to 25 feet bgs to verify the lateral and vertical extent of product-affected soils to be removed.
- Excavation of saturated soils using drag-line equipment methods from the water table depths to approximately 25 feet bgs. Excavations will be sloped, where feasible, to avoid the need for shoring. However, sheet pile shoring may be required to keep excavations open adjacent to the existing shoreline riprap embankment or in areas where excessive fill material sloughing occurs.
- Excavations will be performed to depths established by the pre-excavation sampling. Final confirmation soil sampling will not be representative because of the saturated conditions present, and therefore was not included in the costs.
- Extraction of floating product from open excavations using a top loading skimming system.

Before excavation, four existing deep B-zone monitoring wells located at the site boundaries will require protection for future site monitoring use. Ten existing shallow and deep wells will be removed during excavation activities.

The same considerations for the excavation to the water table options (Section 6.2.1), regarding existing underground utilities and physical debris separation, will also apply for this option. It is anticipated that de-watering of the excavation will not be feasible because of the high volumes of water likely to be produced. This option does not include costs associated with the handling and treatment of groundwater other than residual fluids.

The volume of soil to be excavated was estimated based on the estimated limits of free product contours presented in Figures 3-2 through 3-6. The estimated volume of soil to be excavated from 11 to 25 feet bgs is approximately 39,000 cubic yards. The areal extent of assumed limits is shown in Figure 6-1. Pre-excavation sampling is proposed to collect soil samples from water table depths to 25 feet bgs according to a systematic grid sampling approach. Pre-excavation sampling may reduce or increase this estimated quantity of soils. Soil sampling protocols and methods will be presented in the Removal Action Work Plan. Subsequent disposal options assume that 100 percent of this saturated material will require off-site disposal at a Class II landfill based on reviews of available analytical results. Panel excavation techniques would likely be utilized in place of sheet piling when excavating soils above the water table. As mentioned above, dragline excavation techniques are assumed for excavations below the water table given the wet working conditions and are included with cost estimates for this option.

For a 39,000-cubic yard quantity of stockpiled soils, an estimated 9-acre storage area will be required for temporary soil storage, sampling, and segregation. Additionally, a 7-acre site is needed for stockpiling soils generated from the excavation to the water table option. While a 16-acre storage site is not available directly adjacent to the Site, a 3.4-acre rectangular area located just east of the Site between "K" and "J" Streets could be used for these purposes. This assumes that scrapers will be used to stockpile soils in trapezoidal windrows (300 feet long, 20 feet wide at the base, and 8 feet wide at the top). Additionally, a 1.25-acre asphalt paved lot is vacant and accessible for material storage purposes approximately 500 feet to the northwest of the Site. Staging of the excavation activities will be necessary to accommodate the limited storage area.

Stockpiling of soils will require a 60-mil plastic sheeting as well as berming along the boundary of the area for drainage control. Soils removed from near or below the water table, which will contain free fluids, will be stockpiled in the area directly east of the excavation. The lined stockpile area will be sloped to a sump area where free fluids will be collected and pumped through an oil/water separator, where any free-phase product will be collected. Residual fluids will then flow by gravity back into the excavation. During rainy weather, stockpiled soil will be covered with plastic sheeting to minimize infiltration of rainwater into stockpiled soil.

During excavation of the saturated soil, free-phase product floating on the water surface in the excavation will be removed using a skimming system as described previously (Section 6.2.1.1). Stockpiled saturated soils may require aeration to bring the moisture content of the soil to acceptable levels (typically less than 50 percent moisture content) for disposal purposes. While the BAAQMD regulates uncontrolled VOC emission rates from product-affected soils, the levels of VOCs within the saturated soils may be low enough to allow for uncontrolled aeration.

6.2.2.2 Effectiveness

Excavation below the water table will remove product and product-affected soils, however, visual observations to confirm cleanup will not be possible below the water table since de-watering operations are not being considered because of cost effectiveness and technical constraints. Additionally, confirmation soil sampling in saturated conditions is not recommended because of problems inherent in interpreting analytical results with this type of sampling. The overall remaining risk to human health will be reduced through product-affected soil removal, although complete removal of all product and product-affected soils cannot be guaranteed. Future land-use restrictions will not be necessary. Overall protection of the environment and permanence will likely be achieved since product and product-affected soils will be removed to the extent feasible, and any remaining hydrocarbons will attenuate naturally with time. This option will significantly reduce or possibly eliminate the toxicity and mobility of the contaminant while completely or nearly reducing its volume. It is expected that this alternative will comply and can be conducted in accordance with ARARs identified in Chapter 4.0. For these reasons, the remedial action objectives are achievable and the long-term effectiveness is considered to be good.

The short-term effectiveness is considered to be very good for excavation below the water table. Protection of the community and workers will be easily provided through standard environmental engineering controls and practices. On-site workers will be protected from site hazards through implementation of a site-specific health and safety plan. Removal operations will comply with federal and state air quality and RCRA waste handling requirements. This option may require a longer time schedule because it would take significantly longer to excavate, handle, and dry the increased volume of soils generated as compared to other removal options.

6.2.2.3 Implementability

The reliability of excavation below the water table is considered good because it would involve dragline excavation techniques from water table depths to 25 feet bgs (panel excavation techniques would also be required adjacent to the shoreline during initial excavations from ground surface to the water table). Both panel and dragline excavation techniques require specialized equipment and skilled operators to successfully complete this work. Sheet pile shoring would be required at depths below the water table during excavations adjacent to the shoreline. Operational difficulties exist with encountering subsurface obstructions, and in transporting and handling saturated, product-affected soils for stockpiling and drying. Additionally, the volume of product and product-affected soils could be well under or over estimated based on the limited available data and the reliability of analytical sampling results in soil samples taken from below the water table. Large increases in volume could make implementation of this option more difficult. Staging of the work will be required because of stockpiling storage constraints and will be especially critical given the large volume of soils generated and the requirement for soils de-watering and water handling. Overall, the technical feasibility of this option is considered to be fair.

There are no requirements for easements or right-of-way and zoning variances to perform this work. The City of San Francisco may require application for a permit to discharge any wastewater generated from decontamination activities to the City's wastewater treatment system. Notification to the BAAQMD is recommended to comply with air quality ARARs such as those for fugitive dust and uncontrolled VOC emissions. However, there are no permits necessary from this agency. The administrative feasibility for this option is considered very good.

6.2.2.4 Cost

Table A-2 presents the estimated costs for the excavate below the water table option. The total direct and indirect costs included have been developed from reviews of recent contractor and vendor estimates. Dragline and panel excavation techniques are associated with this option and are included in the cost estimate. Long-term groundwater monitoring is not included in the estimated costs. The total estimated cost for this option as reflected in Table A-2 is $722,000. The following conditions during removal activities could significantly increase costs:

- Excavation of large boulders or other debris.
- Subsurface obstructions during lag pile shoring installation.
- Significant variations of product-affected soil and free-phase product volumes from estimated volumes.

6.3 CONTROL OPTIONS

Control options will not remove or treat the waste oil product, but will confine it and prevent its migration. From the initial screening of process options (Chapter 5.0), installation of a sheet pile subsurface barrier appears to be the most implementable control option.

6.3.1 Sheet Piling Subsurface Barrier

6.3.1.1 Description

This process will consist of driving interlocking steel piling sections into the Bay mud using resonant, vibratory, or hydraulic hammering equipment. The sheet piling subsurface barrier will then function as a low permeability hydraulic barrier isolating product and preventing lateral migration to the Bay.

The implementation of the sheet pile consists of the following activities:

- "Pre-installation" soil sampling from ground surface to 25 feet bgs to verify the lateral and vertical extent of soils contamination, and to verify the lateral length for the sheet pile barrier.

- Conduct "geo-probe" or cone penetrometer testing (CPT) along the proposed wall location to evaluate the presence of obstructions in the fill material and delineate the Bay mud/artificial fill interface.
- Drive interlocking steel sheet pile sections approximately 2 feet into Bay mud using resonant, vibratory, or hydraulic hammering equipment.
- Grading and placement of a 6-inch layer of clay material topped with a one foot layer of seeded, fertilized topsoil over the entire area of know affected subsurface.

A pre-installation investigation will be conducted before installation of the wall along the proposed wall length (Figure 6-1) to verify the lateral and vertical extent of affected soil, to identify potential obstructions in the fill material and delineate the Bay mud/artificial fill interface. The proposed wall alignment is preliminary and will be revised based on data gathered in the pre-installation investigations. Soil borings will be drilled to depths of approximately 25 feet bgs according to a systematic grid sampling approach for approximately every 50 linear feet of sheet pile, resulting in a total of approximately 16 soil borings. Soil borings will be drilled using a "geo-probe rig". Alternately CPT will be conducted. Both of these drilling methods do not generate waste soil as the borings are advanced by hydraulically pushing the drilling and soil sampling tools. If the "geo-probe" drilling rig is used, soil samples will be collected at 5-foot intervals using a split-spoon soil sampler for visual observations. Each boring will be backfilled to the ground surface with cement grout. Soil sampling protocols and methods will be presented in the Removal Action Work Plan. Analytical results will be reviewed to determine an appropriate length for the sheet pile wall.

The sheet pile will be approximately 800 feet long, to a maximum depth of approximately 27 feet bgs, just inside the riprap shoreline of the Bay (Figure 6-1). While the sheet pile will not completely surround the IR-03 former waste oil ponds, its placement will better isolate the area from the Bay assuming that groundwater flow will eventually return to a natural direction from inland to the Bay. The wall will be installed to curve around the sides of the former oil pond perimeter in a half-ellipse shape (See Figure 6-1). The wall will be installed down through the saturated soil to the Bay mud which occurs about 18 to 25 feet bgs. The wall will be installed approximately 2 feet into Bay mud to form a continuous low permeability barrier. Cathodic protection may be necessary to prevent corrosion of the steel wall over time. As an option for alternatives involving soil excavation to water table depths, or for any future final remedial action involving soils excavation proposed for Parcel E, the sheet pile barrier may be designed for use as shoring utilizing a series of tiebacks and passive resistance derived from the depth of the wall. Additionally, the sheet piling may be extended horizontally through installation of additional interlocking sheet piles should a future final remedial action proposed for Parcel E include such a barrier.

Site restoration activities under this option would include scraping and grading operations to place a 6 inch clay layer covered with a 1 foot topsoil layer over the entire area of known affected subsurface. The clay layer will be placed to minimize rainfall infiltration over the area and to limit the effects of residual affected groundwater from product and product-affected soils left in place. The topsoil will be placed and seeded with native grass (with consideration given for listed California plants) to complete the site restoration. Seeding is recommended for erosion control purposes until such time that a final remedial action is implemented for Parcel E. The backfill shall be appropriately graded to allow for proper surface runoff/drainage over the area.

6.3.1.2 Effectiveness

The sheet pile will not reduce hydrocarbon concentrations in the soil, but will reduce hazardous substance migration. The Bay and adjacent environments will be more protected from the TPH-affected soil and groundwater matrix. This remedial action does not reduce toxicity or volume, but does reduce the mobility of the product. The permanence of the sheet pile will be limited to some degree by the potential for steel corrosion over time, although protection (i.e., cathodic protection) may be installed to protect the integrity of the wall. This option should include regional groundwater pumping for gradient control as part of the final remedy to ensure migration control. Land use restrictions or deed restrictions are likely to be necessary. For these reasons the long-term effectiveness is considered to be good for this option.

The short-term effectiveness is considered excellent for this option. Protection of the community and workers will be easily provided through environmental engineering controls and practices. On-site workers will be protected from site hazards through implementation of a site-specific health and safety plan. Removal operations will be controlled to comply with federal and state air quality and RCRA waste handling requirements. The handling of affected soil is minimized, significantly reducing associated health and safety issues. This option could be completed in a timely manner because installation rates are high based on previous full-scale applications of these technologies.

6.3.1.3 Implementability

The reliability of sheet piling is considered excellent. The technology is well known and has been implemented full scale at numerous sites. Specialty contractors and equipment are readily available for this process and the required equipment is based on standard construction equipment.

The operational difficulty of main concern is potentially encountering subsurface obstructions (i.e., buried riprap and debris). If refusal occurs, additional pile driving will be necessary to deviate around the obstacle. This may slow installation and increase wall length, but the integrity and continuity of the wall will not be compromised. The fluctuations of hydraulic pressures caused by tidal influences are not expected to adversely affect this type of construction.

Construction equipment will require a 40-foot space on the inside (inland side) of the sheet pile, and a 10-foot space on the outside of the wall. Therefore the sheet pile will be installed approximately 10 feet from the Bay riprap shoreline. Three wells, located within the 50-foot strip along the Bay shoreline, will be protected during the sheet pile installation and used for subsequent monitoring.

Air quality and health and safety concerns will be easily addressed based on past successful permitting and operating experiences. No excavation or soil handling is necessary, reducing the difficulties associated with these tasks. The technical feasibility of this option is considered to be very good. Because the Site is federal property, there are no requirements for easements or right-of-way and zoning variances to perform this work. The administrative feasibility for this option is considered very good.

6.3.1.4 Cost

Table A-3 presents the estimated costs for installing sheet pile. The total direct and indirect costs have been developed from reviews of recent bid costs and contractor estimates. If large boulders or other debris are encountered during driving operations, costs may significantly increase. Cost estimates assume standard joints are sufficient to meet permeability constraints. Groundwater monitoring costs are not included. These costs will be addressed in other documents as part of the final remedial action implemented for Parcel E. The total estimated cost for this option as reflected in Table A-3 is $685,000. The total estimated cost does not include pre-installation sampling costs estimated at

$52,000 or surface replacement costs (clay/topsoil) estimated at $140,000. However, these costs have been included in the total estimated cost of $877,000 reflected in Table 7-2 for Alternative 1.

6.4 DISPOSAL OPTIONS

6.4.1 Off-Site Soil Disposal

6.4.1.1 Description

The off-site disposal option for soils includes the sampling, transportation, and disposal of product-affected soils at an appropriate state-permitted landfill facility. The State of California has three classes of landfills as described below.

Class I landfills accept hazardous waste as defined by state and federal regulations.

Class II landfills accept designated wastes as defined by Title 22 CCR and generally accept soil according to the following waste parameters:

- Up to Title 22 CCR hazardous limits.
- 20,000 ppm for diesel.
- 5,900 ppm for gasoline.
- 10,000 ppm for waste oil.
- Less than 50 percent moisture content.
- Flashpoint greater than 140°F.

Class III landfills generally accept only nonhazardous solid wastes according to the following parameters:

- 1,000 ppm for diesel and waste oils.
- 100 ppm for gasoline, kerosene, jet fuels.
- Less than 50 percent moisture content.
- Flashpoint greater than 140°F.

Previous soil sampling and boring log information indicates that product-affected soils may be disposed of at a Class II permitted facility. The estimated 39,200 tons (or approximately 50 percent) of soil from the excavation to water table option will need to be disposed of at this Class II facility. As required by the landfill facilities, stockpile characterization sampling will be performed at 50 cubic yard intervals for TPH, and at 500 cubic yard intervals for metals, before final segregation and transportation.

The off-site soil disposal option consists of the following activities:

- Soils characterization sampling at the specified intervals for TPH and metals constituents.
- Drying of saturated, stockpiled soils to obtain a moisture content estimated at less than 50 percent.
- Segregation of soils acceptable for disposal at a Class II landfill facility.
- Transportation and disposal of soils at an appropriate landfill facility.

6.4.1.2 Effectiveness

The off-site disposal option (e.g., landfill disposal) will reduce potential risks associated with human contact with product-affected soils at the Site. However, a long-term liability is created for the Navy because treatment at the landfill is not required and the effectiveness and long-term integrity of the landfill will determine whether the degree of mobility and potential risk have been reduced. Written indemnification from landfills is available and offsets this liability. However, written indemnification has not been proven to completely remove the liability. Protection of the environment is considered good because physical removal significantly reduces any threat to the environment at the Site. The long-term environmental protectiveness at the landfill depends on proper operation and maintenance activities and the effectiveness of regulatory oversight. The RAO is achieved by landfilling because the potential migration of product to surface or groundwater is significantly reduced. It is expected that this option will comply and can be conducted in accordance with ARARs identified in Chapter 4.0. The long-term effectiveness is considered to be very good for this option.

The short-term effectiveness is considered good for this option. Off-site transportation introduces the potential risk of accidental release to the community. Protection of on- and off-site workers will be maintained through standard engineering controls and health and safety practices common to this option. Removal operations will comply with federal and state air quality and RCRA waste handling requirements. This option can be completed in a timely manner because it could be accomplished without prior treatment (other than for moisture content) and transportation times are not lengthy given the proximity of the landfills to the Site.

6.4.1.3 Implementability

The reliability of this option is considered excellent because transportation and disposal of TPH- and metals-affected wastes have become a common practice, and the necessary equipment is readily available. Two Class III landfills, the Ox Mountain facility in Half Moon Bay and the Vasco facility in Livermore, are located near the Site. Nearby Class II landfills include the Keller Canyon facility in Pittsburgh (45 miles) and the Altamont facility in Livermore (55 miles). Operational difficulties exist in pre-treating soils for moisture content, but these are not considered unusual for this type of work. Previous experiences with off-site disposal indicate that air quality and health and safety concerns will be easily addressed, considering the moisture content and the low volatility of the heavy waste oil product. The technical feasibility of this option is considered to be excellent.

While the Navy will not have to apply for a permit for landfill disposal, the landfill selected must be in compliance with its own state and federal permits and the CERCLA off-site rule. Notification to the BAAQMD is recommended to comply with air quality ARARs such as those for fugitive dust and uncontrolled VOC emissions, however, there are no permits necessary from this agency. The administrative feasibility for this option is considered very good.

6.4.1.4 Cost

Tables A-4 and A-5 present the estimated costs for the off-site soil disposal option for soil excavated from above the water table and soil excavated from below the water table, respectively. The total direct and indirect costs have been developed from reviews of recent bid costs and contractor estimates. Post removal site control costs are not included because these costs will consist of continued groundwater monitoring, an activity that will be addressed in other documents as part of the final remedial action implemented for Parcel E. The total estimated cost for the off-site disposal with soil excavated from above the water table as reflected in Table A-4 is $1,404,000. The total estimated cost for the off-site disposal with soil excavated from below the water table as reflected in Table A-5 is $2,059,000. The following conditions during removal activities could significantly increase costs:

- The volume of soil to be transported and disposed of at landfills may be underestimated.
- Moisture content of less than 50 percent may be difficult to achieve, necessitating additional soil handling.
- Unit costs and acceptance criteria at landfills may vary.

6.4.2 Product Recycling

6.4.2.1 Description

The product recycling option includes the sampling, transportation, and disposal of product at an appropriate, permitted nonhazardous or hazardous waste oil recycler. There are several nonhazardous oil recyclers and refineries located in the vicinity of HPA including the Seaport Facility in Redwood City and the Evergreen facility located in Newark, California. The only hazardous waste refinery within California capable of refining used oils is the DeMenno/Kerdoon (DK) facility located in Compton, California. Based on analysis of waste oils collected from monitoring wells at IR-03, the LNAPL has physical characteristics similar to a used motor oil. Grab samples of the free-phase oil floating on the water table were collected from four wells in the vicinity of IR-03 and were analyzed for metals, VOCs, SVOCs, PCBs and pesticides, TPH as diesel, density, and ignitability. The minimum and maximum concentrations of these compounds are summarized in Table 3-1. As shown, the oil contained several SVOC constituents, PCBs, and metals concentrations. Collected product could be recycled at a nonhazardous facility, however, further characterization sampling of stored product will be required by these facilities. The product is acceptable for recycling at the hazardous DK facility, but will require additional characterization sampling. For purposes of the EE/CA, we have assumed that the product will be recycled at a hazardous waste oil recycler.

The product recycling option consists of the following activities:

- Product characterization sampling at frequencies required by the recycling facility.
- Transportation and disposal of product at an appropriate recycling facility.

6.4.2.2 Effectiveness

Product recycling will significantly reduce potential risks associated with human contact with product at the Site. Additionally, no long-term liability is created since the end-product of recycling is a base stock oil and remaining byproducts are commonly re-sold for use at asphalt production plants. The toxicity and mobility of the product are significantly reduced with its removal from the Site. Protection of the environment is considered good because physical removal reduces any threat to the environment at the Site. The remedial action objectives are achieved by recycling since the potential migration of product to groundwater is significantly reduced. It is expected that this option will comply and can be conducted in accordance with ARARs identified in Chapter 4.0. The long-term effectiveness is considered to be excellent for this option.

The short-term effectiveness is considered good for this option. Off-site transportation introduces the potential risk of accidental release to the community. Protection of on- and off-site workers will be maintained through standard engineering controls and health and safety practices common to this option. This disposal option can be implemented in a timely manner.

6.4.2.3 Implementability

The reliability of this option is considered excellent since transportation and disposal of waste oils have become a common practice, and the equipment necessary is readily available. Air quality and health and safety concerns will be easily addressed considering the heavy waste oil product and its relative toxicity. The technical feasibility of this option is considered to be excellent.

There are no requirements for easements or right-of-way and zoning variances to perform this work because the Site is located within City of San Francisco property. While the Navy will not have to apply for a permit for recycling oil, the recyclery selected must be in compliance with its own state and federal permits. The administrative feasibility for this option is considered very good.

6.4.2.4 Cost

Table A-6 presents the estimated costs for the product recycling option. The total direct and indirect costs have been developed from reviews of recent bid costs and vendor cost estimates. The total estimated cost for this option as reflected in Table A-6 is $69,000.

The following condition during removal activities could significantly increase costs:

- Volume of product to be transported and disposed of at the recycling facilities may be underestimated.

6.5 RESTORATION OPTIONS

After soil removal, the excavation will need to be restored to grade for future use. The two restoration options retained for further consideration after the initial screening include (1) backfilling with excavated overburden not requiring off-site disposal, and (2) backfilling with clean imported fill.

6.5.1 Backfill with Excavated Unaffected Overburden

6.5.1.1 Description

With this option, the excavation will be filled with overburden that did not require off-site disposal. However, as for the backfill with new fill options, any excavations below the water table will need to be restored with crushed rock or pea gravel since it will not be possible to provide compaction through the standing water in the excavation. The crushed rock or pea gravel will be imported to fill the excavation to the water level (approximately 10 feet bgs). A geotextile fabric will be placed over the rock to prevent the infiltration of fines. Treated soil or overburden will then be placed in the excavation to a depth of 1.5 foot bgs and compacted in lifts to 90 percent relative compaction. A 6-inch layer of clay material will then be placed to minimize rainfall infiltration over the area followed by a 1 foot layer of top soil. The topsoil will be placed and seeded with native grass (with consideration given for listed California plants) to complete the site restoration. Seeding is recommended for erosion control purposes until such time that a final remedial action is implemented for Parcel E. The backfill shall be appropriately graded to allow for proper surface runoff/drainage over the area.

This restoration option is only used in conjunction with the backfill with new fill option for both excavation to the water table and excavation below the water table removal options.

6.5.1.2 Effectiveness

Backfilling with overburden not requiring off-site disposal is considered to have very good long-term effectiveness. The overburden will have been segregated and sampled to confirm it does not contain free-phase product or concentrations of metals exceeding HPALs. The final top layer of backfill will consist of 1 foot of topsoil. This will reduce the risk of potential human contact with any remaining product-affected soils or soils with natural metals from the original fill. For this reason as well, use of overburden soil will be considered protective of human health. The use of a 6-inch clay layer below the topsoil will inhibit rainfall infiltration over the area, thereby limiting the possibility of future groundwater degradation from any residual product or product-affected soils. It is expected that this option will comply and can be conducted in accordance with ARARs identified in Chapter 4.0. Overall, the long-term effectiveness is considered to be excellent for this option.

The short-term effectiveness is considered excellent for this option. Protection of the community and workers will be easily provided through environmental engineering controls and practices. On-site workers will be protected from site hazards through implementation of a site-specific health and safety plan. Removal operations will comply with federal and state air quality and RCRA waste handling requirements.

6.5.1.3 Implementability

The reliability of backfilling with overburden not requiring off-site disposal is considered excellent. Backfilling and associated operations are easily conducted using standard construction equipment. Based on fill assumptions, approximately 47,000 cubic yards of overburden are needed to fill the excavation. Any excess overburden may be stored and used as fill elsewhere on HPA. Standard dust control operation will need to be implemented during backfilling and compaction operations. Overall, the technical feasibility of this option is considered to be good.

There are no permits necessary for backfilling the excavation. Overall, the administrative feasibility for this option is considered good.

6.5.1.4 Cost

Tables A-7 and A-8 include estimated costs for the backfilling with clean overburden option. The total direct and indirect costs have been developed from reviews of recent bid costs and contractor estimates. The cost calculations assume that clean overburden will only be replaced above the groundwater level (11 feet bgs) up to 1.5 foot bgs. This will leave a volume of clean overburden to be used as fill elsewhere on site. The Navy has indicated that excess soil could be used as a future landfill cover foundation material for the industrial landfill in Parcel E.

Post removal site control costs are not included since these costs will consist of continued groundwater monitoring, an activity that will be addressed in other documents as part of the final remedial action implemented for Parcel E. The total estimated cost for this option as reflected in Tables A-7 and A-8 is $135,000.

The following condition during replacement activities could significantly increase costs:

- Volume of the excavation that requires fill may be underestimated.

6.5.2 Backfilling with New Fill

6.5.2.1 Description

With this option, the excavation will be backfilled and compacted with new fill materials and overburden not requiring off-site disposal. As described in Section 6.5.1, excavations below the water table will be restored with crushed rock or pea gravel to reduce the need for compaction. The crushed rock or pea gravel will be imported to fill the excavation to the water level (approximately 10 feet bgs). A geotextile fabric will be placed over the rock to prevent infiltration of fines. Lifts of clean overburden followed by new fill will then be placed in the excavation and compacted in lifts to 90 percent relative compaction to a depth of 1.5 feet bgs. A 6-inch layer of clay material will then be placed to minimize rainfall infiltration over the area followed by a 1 foot layer of top soil. The topsoil will be placed and seeded with native grass (with consideration given for listed California plants) to complete the site restoration. Seeding is recommended for erosion control purposes until such time that a final remedial action is implemented for Parcel E. The backfill shall be appropriately graded to allow for proper surface runoff/drainage over the area.

6.5.2.2 Effectiveness

The placement of new, clean fill below the water table or in the upper portions of the excavation is considered to have good long-term effectiveness because the product-affected soils will have been removed. This option is considered to be protective of human health and the environment because of the new, clean fill and topsoil layers placed in the upper portion of the excavation. Additionally, the use of a 6-inch clay layer below the topsoil will inhibit rainfall infiltration over the area, thereby limiting the possibility of future groundwater degradation from any residual product or product-affected soils. It is expected that this option will comply and can be conducted in accordance with ARARs identified in Section 4.0.

The short-term effectiveness is considered excellent for this option. Protection of the community and workers will be easily provided through environmental engineering controls and practices. On-site workers will be protected from site hazards through implementation of a site-specific health and safety plan. Removal operations will comply with federal and state air quality and RCRA waste handling requirements.

6.5.2.3 Implementability

Technical and administrative implementation alternatives and available services and materials will be considered for backfilling with new fill. The reliability of backfilling with new fill is considered excellent. Backfilling and associated compaction of the excavation with clean fill is easily conducted using standard construction equipment. Standard dust control operations will need to be implemented during backfilling and compaction activities. Overall, the technical feasibility of this option is considered to be good. There are no permits necessary for backfilling the excavation. The administrative feasibility for this option is considered good.

6.5.2.4 Cost

Tables A-7 and A-8 present the estimated costs for the backfilling with new fill option. The costs are divided into the two scenarios: excavation extending to 11 feet bgs (1 foot below the water level), and excavation extending to 25 feet bgs. Costs presented include total direct and indirect costs and have been developed from reviews of recent bid costs and vendor quotations. Post-removal site control costs are not included. These costs will consist of continued groundwater monitoring, an activity that will be addressed in other documents as part of the final remedial action implemented for Parcel E. Included within Tables A-7 and A-8 are line item costs for surface replacement with clay and topsoil which are also associated with the sheet pile barrier control option. The total estimated costs for the backfilling with new fill options as reflected in Tables A-7 and A-8 are $710,000 and $1,512,000, respectively.

The following conditions during removal activities could significantly increase costs:

- Volume of the excavation that requires fill may be underestimated.
- Fill material may not be available from a local source and higher transportation costs may be incurred.

CHAPTER 7.0
REMOVAL ACTION ALTERNATIVES

7.1 TECHNOLOGY COMBINATIONS

In order to develop a removal action for the IR-03 former waste oil reclamation ponds, the specific remedial technologies that have been evaluated in the preceding pages are assembled into one or more alternatives that will encompass all phases of the removal action. Table 7-1 presents several alternatives that combine technologies. These alternatives present a reasonable range of potential removal actions. All of these alternatives meet the goals of the removal action to varying degrees. They vary chiefly in the approach to reducing the threat of migration to San Francisco Bay and overall cost.

Table 7-2 presents the cost for each alternative. These costs are summarized from the detailed technology option cost estimates provided in Appendix A. As shown, proposed removal costs range from $877,000 to $6,548,000, depending on the technologies used in each alternative.

Remedial alternatives are summarized below. Highlights of the effectiveness, implementability, and cost-effectiveness of the alternatives component technologies are also presented.

7.1.1 Alternative 1

Alternative 1 includes installing a sheet piling subsurface barrier to provide a low permeability barrier between the former waste oil ponds and the San Francisco Bay. This alternative is not complex and can be rapidly implemented although sheet piling installation may be problematic because of the potential for encountering subsurface obstacles. The pre-installation investigation will assist in assessing subsurface lithology and presence of rubble and other obstacles. This technology does allow for construction around limited obstructions. Additionally, the top surface of the entire site will be regraded with a 6-inch clay layer and covered with 1 foot of topsoil. This surface replacement will reduce surface-water infiltration, control dust and improve surface drainage characteristics. This alternative is compatible with future remedial action because sheet pile wall can be used as a shored excavation sidewall should the final remedial action involve excavation of affected soils. Additionally, the sheet piling can easily be extended horizontally (i.e., more sheet piles can be added) to lengthen the subsurface barrier should the final remedial action include subsurface barriers in this vicinity. This alternative is the least expensive alternative, estimated at $877,000.

7.1.2 Alternative 2

Alternative 2 includes excavating all affected soils and product to 25 feet bgs with disposal of excavated affected soil and recovered product off site. This alternative provides the highest degree of removal, however, it is relatively problematic to implement in the Site's saturated soils, and it is much more costly than excavating to just below the water table surface. This alternative provides the highest degree of protection of San Francisco Bay and is consistent with future remedial action because it removes most of the contaminants associated with IR-03. However, because of the saturated excavation conditions, it will be difficult to verify that all product and product-affected soils have been removed. Because of the rock fill placed below the water table, it may not be feasible to install future groundwater monitoring or extraction wells in the excavation area if needed. Wells or sumps could be installed as part of backfilling activities, but this would increase cost. Since the excavation will remove most of the contaminants associated with IR-03 and will be restored with clean fill, it would greatly reduce the potential for human exposures, including potential exposures to soil containing hazardous substances. This alternative is the most costly alternative, estimated at $6,548,000.

7.1.3 Alternative 3

Alternative 3 includes excavating hazardous substances, product and product-affected soil to just below the water table and disposing of the excavated soil and recovered product off site and placement of clean overburden and new fill. This alternative also includes installation of a sheet piling subsurface barrier to provide a low permeability barrier between the residual product below the water table and San Francisco Bay. The sheet pile barrier will also serve as shoring during excavations adjacent to the Bay. This alternative would be effective in removing accessible soil and free product above the water table, and provide containment of affected materials not removed below the water table. This alternative is readily implemented using traditional construction techniques. Since the excavation will be restored with clean fill, it would greatly reduce the potential for human exposure, including potential exposures to soil containing hazardous substances. This alternative is compatible with future remedial action since the sheet piling can be extended horizontally if additional barriers are part of the final remedial action. This alternative is the second highest in cost, estimated to be $3,650,000.

7.2 PREFERRED REMOVAL ACTION ALTERNATIVE

Based on the analysis of the removal action technology options completed in Chapter 6.0, the preferred alternative is Alternative 1. Alternative 1 can be rapidly implemented, meets the RAO and ARARs, and is acceptable to the regulatory agencies. The containment of affected materials associated with IR-03 is provided and the threat to San Francisco Bay is reduced. This alternative also provides a cost-effective approach for future remedial alternatives which will be consistent with future remedial actions to be evaluated as part of the RI/FS process for Parcel E.

CHAPTER 8.0
REFERENCES

EMCON Associates. 1987. Confirmation Study, Verification Step, Hunters Point Naval Shipyard (Disestablished), San Francisco, California. March 19.

Harding Lawson Associates. 1993. Draft Treatability Study Work Plan, Operable Unit 1, IR-03, Naval Station Treasure Island, Hunters Point Annex, San Francisco, California. June 17.

———. 1991a. Phase I Aquifer Testing Results: Recommendation for Phase II Aquifer Testing, Naval Station Treasure Island, Hunters Point Annex, San Francisco, California. May 15.

———. 1991b. Product Recovery Site Characterization Investigation, Former Oil Reclamation Ponds, Site IR-03, Naval Station, Treasure Island, Hunters Point Annex, San Francisco, California. Novato, California. May 15.

Lawrence Livermore National Laboratory 1995. Recommendations to Improve the Cleanup Process for California's Leaking Underground Fuel Tanks. October 16.

Mare Island Naval Shipyard (MINS). Asbestos Survey Report of Naval Station Treasure Island, Hunters Point Annex, Parcels B - E, San Francisco, California.

PRC Environmental Management, Inc. 1996. Personal communication with Peter Solberg.

———. 1996a. Final Facility-Wide Groundwater Monitoring Plan, Hunters Point Annex, San Francisco, California. April 5.

———. 1996b. Engineering Evaluation/Cost Analysis, Site IR-1/21: Industrial Landfill Groundwater Plume, Draft Final. May 24.

———. 1995a. BRAC Cleanup Plan, Revision 1. Engineering Field Activity West, Naval Facilities Engineering Command, Hunters Point Annex, San Francisco, California. February 24.

———. 1995b. Draft Calculation of Hunters Point Ambient Levels. Engineering Field Activity West, Naval Facilities Engineering Command, Hunters Point Annex, San Francisco, California. April 11.

REFERENCES (continued)

———. 1994. Technical Memorandum Integration of Facility Wide Hydrogeologic Data (HPA Hydrogeologic Report). Naval Air Station Treasure Island Hunters Point Annex, San Francisco, California. May 27.

PRC Environmental and ECOVA Corporation. 1995. Draft Final Treatability Study Work Plan for Treating Subsurface Petroleum Products at Site IR-03 by Biodegradation. San Francisco, California. February 21.

PRC Environmental Management, Inc. and Harding Lawson Associates. 1993. Draft Final Parcel A Inspection Report, Naval Station Treasure Island, Hunters Point Annex, San Francisco, California. July 30.

State of California State Water Resources Control Board (SWRCB). 1993. California Enclosed Bays and Estuaries Plan. Water Quality Control Plan for Enclosed Bays and Estuaries of California. 93-5WQ. April 11.

United States Environmental Protection Agency. 1995. Region IX Preliminary Remediation Goals July through December 1995. San Francisco, California. September.

———. 1994. Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. July.

———. 1993. Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA. Washington D.C. August.

———. 1992. Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies. EPA/600/SR-92/128. September.

WESTEC Services, Inc. 1984. Initial Assessment Study, Hunters Point Naval Shipyard (Disestablished), San Francisco, California. October.

TABLE 2-1: THREATENED AND ENDANGERED SPECIES
ENGINEERING EVALUATION/COST ANALYSIS, HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

SPECIES	COMMON NAME	STATUS AT HPA	DESIGNATION
Ochorhynchus tshawytscha	Chinook salmon	Observed	M SSC (spring run) SE, FT (winter run)
Spirinchus thaleichthys	Longfin smelt	Observed	FC1
Falco peregrinus	Peregrine falcon	Observed	SE FE
Eremophila alpestris	Horned lark	May be present	SSC FC2
Lanius ludovicianus	Loggerhead shrike	Observed	SSC FC2
Pelecanus occidentalis californicus	California brown pelican	May be present	M SE FE
Geothlypis trichas	Common yellowthroat	May be present	SSC FC2 SBS

Designation Codes:

SSC California Department of Fish and Game Species of Special Concern
SE Listed as endangered by the State of California
FT Listed as threatened by the federal government
FE Listed as endangered by the federal government
FC1 Category 1 candidate for listing by the U.S. Fish and Wildlife Service (sufficient biological information is available to support a proposal to list *taxa* as endangered or threatened)
FC2 Category 2 candidate for listing by the U.S. Fish and Wildlife Service (existing information indicates *taxa* may warrant listing, but substantial biological information necessary to support a proposed rule is lacking)
SBS Sensitive Bird Species are designated as those that could become threatened or endangered in the foreseeable future by the U.S. Fish and Wildlife Service
M Migratory Species

This table has been duplicated from EFA WEST, Hunters Point Annex BRAC Cleanup Plan - Revision 01, dated February 24, 1995.

TABLE 2-2: SUMMARY OF MONITORING WELL CONSTRUCTION DETAIL
ENGINEERING EVALUATION/COST ANALYSIS
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

WELL I.D.	DATE INSTALLED	SCREENED INTERVAL (feet)	TOTAL DEPTH (feet bgs)	WELL DIAMETER (inches)
IR02MW146A	1/7/92	6.0 - 18.0	18.5	4.0
IR02MW173A	1/9/92	6.0 - 19.0	20.0	4.0
IR02MW299A	6/3/92	6.0 - 21.0	21.5	4.0
IR03MW218-A1	10/30/90	4.0 - 10.0	10.0	4.0
IR03MW218-A2	10/31/90	12.5 - 17.5	17.5	4.0
IR03MW218-A3	10/30/90	20.0 - 30.0	30.0	4.0
IR03MW224A	1/6/92	4.5 - 12.5	12.5	4.0
IR03MW225A	12/19/91	4.0 - 19.0	19.0	4.0
IR03MW226A	12/19/92	4.0 - 19.0	19.5	4.0
IR03MW228B	4/8/91	58.0 - 68.0	68.0	4.0
IR03MW342A	6/30/92	5.0 - 14.5	15.0	4.0
IR03MW369A	10/25/95	4.5 - 19.5	20.0	N/A
IR03MW370A	10/25/95	6.0 - 21.0	21.5	N/A
IR03MW371A	10/26/95	6.0 - 21.0	21.5	N/A
IR03MWO-1	8/21/86	2.5 - 17.5	18.5	8.0
IR03MWO-2	8/22/86	3.5 - 20.0	21.0	8.0
IR03MWO-3	8/25/86	4.0 - 19.0	20.0	8.0

NOTES:

N/A - Not Available

bgs - below ground surface

Source: See Appendix B

TABLE 3-1: COMPARISON OF ANALYTICAL RESULTS FOR PRODUCT, SOIL, AND REGULATORY DATA
ENGINEERING EVALUATION/COST ANALYSIS, HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA
(all data in mg/kg)

ANALYTE	Floating Product Values (a)		Soil Values (b)			HPA Ambient Soil Levels	PRGs (d)		TTLC (e)	TCLP (f)	Other
	Min.	Max.	Min.	Max.	Sample Count	(c)	Resid.	Indust.			
TPH											
TPH as Gasoline	—	—	0.5	1,000	123						
TPH as Diesel	480,000	480,000	6.9	8,900	129						
TRPH	800,000	800,000	30	30	30						
Oil & Grease	—	—	38	44,000	129						
SEMIVOLATILE ORGANIC COMPOUNDS											
1,2,4-Trichlorobenzene			—	0.80	142		620 nc	5,500 sat			
1,2,4-Trimethylbenzene			1.3	1.3	1						
1,2-Dichlorobenzene	25	25	—	2.8	142		2,300 nc	2,300 sat			
1,3,5-Trimethylbenzene			1.3	1.3	1						
1,3-Dichlorobenzene	16	16	—	0.79	142		2,800 sat	2,800 sat			
1,4-Dichlorobenzene	32	40	—	12	142		7.4 ca	20 ca			
2(5H)-F,Uranone,5,5-Dimethyl-C6H8O2			2.0	2.3	2						
2,4-Dimethylphenol			—	1.7	142		1,300 nc	14,000 nc			
2,4-Dinitrotoluene			—	0.76	142		130 nc	1,400 nc			
2-Chlorophenol			—	1.5	142		330 nc	3,400 nc			
2-Methyl-4,6-Dinitrophenol			50	91	118						
2-Methylnaphthalene	580	2600	3	92	142						
2-Nitroaniline			—	0.13	143		3.9 nc	41 nc			
2H-Pyran-2,3-Diol,Tetrahydro-Diacetate,Trans-C9H			1.4	1.4	1						
3-Heptanone,2,4-Dimethyl-C9H18O			0.2	2.3	4						
4-Chloro-3-Methylphenol			—	2.0	142						
4-Nitrophenol			—	1.6	142						
7-Methyltridecane			0.5	32	2						
Acenaphthene	60	93	—	33	142		360 (sat)	360 (sat)			
Acenaphthylene			10	19	127						

TABLE 3-1: COMPARISON OF ANALYTICAL RESULTS FOR PRODUCT, SOIL, AND REGULATORY DATA
ENGINEERING EVALUATION/COST ANALYSIS, HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA
(all data in mg/kg)

ANALYTE	Floating Product Values (a)		Soil Values (b)			HPA Ambient Soil Levels	PRGs (d)		TTLC (e)	TCLP (f)	Other
	Min.	Max.	Min.	Max.	Sample Count	(c)	Resid.	Indust.			
Anthracene	44	49	—	54	142		19 sat	19 sat			
Benzo(A)Anthracene			—	18	142		0.61 ca	2.6 ca			
Benzo(A)Pyrene			—	11	142		0.061 ca	0.26 ca			
Benzo(B)Fluoranthene			—	30	142		0.61 cal	2.6 ca			
Benzo(G,H,I) Perylene			—	6.9	142						
Benzo(K)Fluoranthene			—	10	142		0.61 ca	26 ca			
Benzoic Acid			0.11	1.1	133		10^5 max	10^5 max			
Benzyl Alcohol			10	19	118		20,000 nc	10^5 max			
Bis(2-Ethylhexyl)Phthalate			—	39	142		32 ca	140 ca			
Butylbenzylphthalate			—	16	142		13,000 nc	10^5 max			
Chrysene	17	70	—	20	142		6.1 cal	24 sat			
Dibenzo(A,H)Anthracene			0.21	2.1	133		0.061 ca	0.26 ca			
Dibenzofuran	47	47	—	2.9	142		260 nc	2,700 nc			
Diethyl Phthalate			83	83	133		52,000 nc	10^5 max			
Diethylphthalate			0.3	11	9						
Dimethyl Phthalate			10	19	118		10^5 max	10^5 max			
Dimethylphthalate			0.3	11	9						
Docosane			1.6	13	5						
Dodecane,2,7,10-Trimethyl- C15H32			0.5	50	3						
Fluoranthene	37	37	—	60	142		2,600 nc	27,000 nc			
Fluorene	72	200	—	45	142		300 sat	300 sat			
Heptadecane C17H36			2.4	11	5						
Heptadecane,2,6-Dimethyl-C19H40			0.2	87	6						
Hexadecane			0.24	7.5	4						
Hexanedioic Acid, Dioctyl Ester			15	15	1						
Indeno(1,2,3-Cd)Pyrene			41	41	1		0.61 ca	2.6 ca			
Iron,Tricarbonyl[N-(Phenyl-2-Pyridinylmethylene)B			2.1	2.1	1						

TABLE 3-1: COMPARISON OF ANALYTICAL RESULTS FOR PRODUCT, SOIL, AND REGULATORY DATA
ENGINEERING EVALUATION/COST ANALYSIS, HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA
(all data in mg/kg)

ANALYTE	Floating Product Values (a)		Soil Values (b)			HPA Ambient Soil Levels	PRGs (d)		TTLC (e)	TCLP (f)	Other
	Min.	Max.	Min.	Max.	Sample Count	(c)	Resid.	Indust.			
M-Terphenyl			0.24	17	6						
Mcpa			0.34	1.0	4						
N-Nitrosodiphenylamine			—	2.4	142		91 ca	390 ca			
N-Nitrosodipropylamine			0.49	2.8	133		0.063 ca	0.27 ca			
Napthalene	230	550	—	88	142		800 (sat)	800 (sat)			
Octacosane C28H58			0.4	6.6	2						
Octane,2,3,6-Trimethyl- C11H24			1.0	1.0	1						
Octathiocane S8			0.17	0.59	2						
Palmitic Acid			0.74	2.5	2						
Pentachlorophenol			—	1.9	142		2.5 ca	7.9 ca			
Pentacosane C22H52			0.96	7.8	4						
Phenanthrene	160	480	—	97	142						
Phenol			—	1.7	142		39,000 nc	10^5 max			
Pyrene	33	110	—	47	142		2,000 nc	20,000 nc			
VOLATILE ORGANIC COMPOUNDS											
1,1-Dichloroethane			—	0.54	137		840 nc	3,000 nc		0.5	
1,2-Dichloroethene (total)			—	2.0	137		75 nc	270 nc			
1-Dodecanol,ethoxy			0.088	0.088	1						
1,1,2-Trichloroethane			—	0.003	137		1.4 ca	3.3 ca		0.5	
2-Hexanone			—	0.081	137						
Acetone			—	3.7	137		2,000 nc	8,400 nc			
Benzene			—	0.19	137		1.4 ca	3.2 ca		0.5	
Carbon Disulfide			—	0.29	137						
Chlorobenzene	50	60	—	5.8	137		160 nc	570 nc		100	
Ethylbenzene	4.9	7.7	0.0038	6.8	137		690 sat	690 sat			
Methyl Ethyl Ketone			0.015	0.92	128		8,700 ca	34,000 ca		200	
Methyl Isobutyl Ketone			0.0307	0.0307	128						

TABLE 3-1: COMPARISON OF ANALYTICAL RESULTS FOR PRODUCT, SOIL, AND REGULATORY DATA
ENGINEERING EVALUATION/COST ANALYSIS, HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA
(all data in mg/kg)

ANALYTE	Floating Product Values (a)		Soil Values (b)			HPA Ambient Soil Levels	PRGs (d)		TTLC (e)	TCLP (f)	Other
	Min.	Max.	Min.	Max.	Sample Count	(c)	Resid.	Indust.			
Methylene Chloride			—	0.24	137		11 ca	25 ca			
Toluene	0.82	0.82	—	0.84	137		1,900 ca	2,800 ca			
Xylenes	3	26	0.002	32	137		990 sat	990 sat			
Tetrachloroethene			—	0.007	137		7.0 ca	25 ca		0.7	
Trichloroethene			—	0.38	137		7.1 ca	17 ca		0.5	
PESTICIDES / PCBs											
4,4-DDD			—	0.320	138		1.9 ca	7.9 ca	1.0		0.14 g
4,4-DDE			—	0.054	138		1.3 ca	5,6 ca	1.0		0.1 g
4,4-DDT			—	0.380	138		1.3 ca	5.6 ca	1.0		0.14 g
Aroclor 1016	4.2	6.4	—	—	—		4.9 nc	65 nc			1.0, 10-25 h
Aroclor 1260	9.1	32	—	12	138		0.066 ca	0.34 ca			
Beta BHC			—	0.0082	138						
METALS											
Aluminum	4.5	7.1	3,298	53,299	128		77,000 nc	100,000 max			
Antimony			3.5	310	128	9.05			500		
Arsenic			0.33	640	128	11.10	220nc/0.38ca	2.4 ca	500	5	
Barium	2.5	12.6	9.9	2,700	128	314.36	5,300 nc	100,000 max	10,000	100	
Beryllium			0.21	3	128	0.71	0.14 ca	1.1 ca	75		
Cadmium			0.36	7.9	128	3.14	9.0 cal	850 nc	100	1	
Chromium (Total)	0.96	7.3	34	1,430	128	(c)	210 ca	450 ca	2,500 *	5	
Cobalt			3.7	120	128	(c)	4,600 nc	97,000 nc	8,000		
Copper	150	4,706	6	10,500	128	124.31	2,800 nc	63,000 nc	2,500		
Lead	9.9	359	0.81	2,059	128	8.99	130 cal	1,000 nc	1,000	5	
Manganese	0.26	0.79	83	13,000	128		380 nc	7,800 nc			
Mercury			0.09	5.6	128	2.28	6.5 nc	68 nc	20	0.2	
Molybdenum			0.73	1,400	128	2.68	380 nc	8,500 nc	3,500		
Nickel	12.2	23.9	22	1,802	128	(c)	150 cal	34,000 nc	2,000		

TABLE 3-1: COMPARISON OF ANALYTICAL RESULTS FOR PRODUCT, SOIL, AND REGULATORY DATA
ENGINEERING EVALUATION/COST ANALYSIS, HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA
(all data in mg/kg)

ANALYTE	Floating Product Values (a)		Soil Values (b)			HPA Ambient Soil Levels	PRGs (d)		TTLC (e)	TCLP (f)	Other
	Min.	Max.	Min.	Max.	Sample Count	(c)	Resid.	Indust.			
Selenium	1.1	1.1	0.13	3.8	128	1.95	380 nc	8,500 nc	100	1.0	
Silver	0.32	0.32	0.32	15	128	1.43	380 nc	8,500 nc	500	5.0	
Vanadium	13	57.5	23	307	128	117.17	540 nc	12,000 nc	2,400		
Zinc	5.6	29.3	9.0	4,120	128	109.86	23,000 nc	100,000 max	5,000		

NOTES:

Only detected concentrations are presented.

All values in mg/kg.

Detection limits are included in Appendix B.

(a) Results of discrete oil samples obtained from Wells IR03MW0-2, IR03MW0-3, IR02MW146A, and IR02MW173A and composite oil sample from same wells (HLA 1993).

(b) *Soil data from previous investigations* (see Appendix B).

(c) Ambient soil levels from PRC, April 11, 1995. Hunters Point ambient soil levels for chromium, cobalt, and nickel are based on the concentration of magnesium in each sample; thus, no single value applies to all samples.

(d) PRG - U.S. EPA Region IX Preliminary Remediation Goals:

ca - *carcinogenic*
cal - California Modified PRG
max - maximum allowed
sat - saturated level in soils
nc - non-carcinogenic

(e) State of California Total Threshold Limit Value (TTLC) in mg/kg.

(f) TCLP - Toxicity Characterization Leaching Potential

(g) State of California Soluble Threshold Limit Value (STLC) in mg/L.

(h) Toxic Substances Control Act (TSCA) PCB Spill Cleanup Policy, recommended cleanup level is 1 mg/kg for residential and 10-25 mg/kg for industrial land use.

(*) Chromium and/or chromium III compounds.

Shading indicates analyte with maximum concentration exceeding Residential PRGs or TTLCs, or both.

FINAL
TABLE 4-1: POTENTIAL LOCATION-SPECIFIC ARARs
ENGINEERING EVALUATION/COST ANALYSIS, HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

Regulation	Purpose/Requirement	Applicability to Removal Action	Citation	Preliminary Determination
Potential Location-Specific Federal and State ARARs				
Coastal Zone Management Act; California Coastal Act	Requires activities be conducted in a manner consistent with coastal zone management programs.	Parcel E and therefore the IR-03 site is within a coastal zone. Intertidal mud flats are located adjacent to IR-03. For any removal action involving discharge within the coastal zone this requirement is applicable. Section 30232 within the California Act specifically provides for effective cleanup of coastal zones affected by petroleum wastes.	Section 307(c) of 16 USC 1451 et seq. PRC Div. 20, Sections 30,000 et seq.	Applicable
Endangered Species Act; California Endangered Species Act	Requires action to avoid jeopardizing the continued existence of listed or endangered or threatened species or modification of their habitat.	Seven threatened and endangered species have been previously identified (Table 3-11 of the BCP) as existing near or within the boundaries of HPA. The BCP also identifies 21 California special animals and 2 species of special plants.	16 USC 1531 et seq.; 50 CFR Part 402; 40 CFR 6.320(h); FGC Div. 3, Chapter 1.5, Section 2050 et seq.	Applicable
Protection of Wetlands Executive Order 11990	Limits adverse impacts to wetland areas, both in the short and long term, by requiring federal agencies "avoid direct or indirect support of new construction in wetlands whenever there is a practicable alternative."	Four wetland areas were identified within Parcel E in the HPA Base Closure Plan. The two wetland areas nearest to IR-03 are located approximately 1,000 feet to the southeast and northwest of the site, respectively.	40 CFR Part 6, Appendix A and Executive Order 1190	Applicable

Notes:

ARAR	Applicable or Relevant and Appropriate Requirement	BCP	HPA Base Closure Plan	CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980	CFR	Code of Federal Regulations	FGC	California Fish and Game Code
		HPA	Hunters Point Annex	LUFT	Leaking Underground Fuel Tank
OSWER	Office of Solid Waste and Emergency Response	PCB	Polychlorinated Biphenyls	ppm	parts per million
PRG	Preliminary Remediation Goal	TBC	To Be Considered	TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act	PRC	California Public Resources Code		

TABLE 4-2: POTENTIAL ACTION-SPECIFIC ARARs
ENGINEERING EVALUATION/COST ANALYSIS, HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

Action	Regulation	Purpose/Requirement	Applicability to Removal Action	Citation	Preliminary Determination
Potential Action-Specific Federal and State ARARs					
Activities relating to the handling of affected soils and floating product	Resource Conservation and Recovery Act/Hazardous Waste Control Act	Provides criteria for determining whether a solid waste is a RCRA hazardous waste.	Applicable for determining whether soils and floating product removed from IR-03 are RCRA hazardous wastes.	40 CFR Part 261 and 22 CCR Div. 4.5, Chapter 11	Applicable
Excavation and off-site disposal of hazardous soils/recycling of floating product	Resource Conservation and Recovery Act (RCRA); Generator Requirements	Provides general requirements for generators of RCRA hazardous wastes; establishes criteria for classification of solid and hazardous waste disposal facilities.	Generator requirements will be applicable for excavated soils or floating product that is considered a RCRA hazardous waste and disposed of offsite.	40 CFR Part 262 and 265 and 22 CCR Div. 4.5, Chapter 12	Applicable
Excavation and temporary storage of hazardous soils on site	RCRA; Treatment and Storage Requirements	Provides general requirements for generators of RCRA hazardous wastes; establishes requirements to prevent unknowing and unauthorized entry to active portions of the facility.	Temporary storage of excavated, potentially hazardous soils may be required on site; site access controls will need to be established.	40 CFR Part 265	Applicable
Excavation, treatment and/or redeposition of soils on site	Clean Air Act; State Implementation Plan; Volatile Organic Compound (VOC) Emissions Requirements	Establishes requirements for excavating, stockpiling and controlling aeration of soils contaminated with VOCs.	Contaminated soils containing VOCs at low levels will be excavated, stockpiled, covered and temporarily stored.	BAAQMD Regulation 8, Rule 40	Relevant and Appropriate

FINAL
TABLE 4-2: POTENTIAL ACTION-SPECIFIC ARARs
ENGINEERING EVALUATION/COST ANALYSIS, HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

Action	Regulation	Purpose/Requirement	Applicability to Removal Action	Citation	Preliminary Determination
Potential Action-Specific Federal and State ARARs					
All on-site removal activities	Clean Air Act; State Implementation Plan; Fugitive Dust Requirements	Establishes requirements to limit the quantity of particulate matter emissions from construction, demolition, excavation and related activities.	Excavation and handling of excavated soils must be conducted in compliance with fugitive dust requirements.	BAAQMD Regulation 6	Applicable

Notes:

ARAR	Applicable or Relevant and Appropriate Requirement	BAAQMD	Bay Area Air Quality Management District
CCR	California Code of Regulations		
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980	CFR	Code of Federal Regulations
HPA	Hunters Point Annex	OSWER	Office of Solid Waste and Emergency Response
ppm	parts per million	PRG	Preliminary Remediation Goal
RCRA	Resource Conservation and Recovery Act	TBC	To Be Considered
TSCA	Toxic Substances Control Act	VOC	Volatile Organic Compound

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TABLE 5-1: SCREENING OF PROCESS OPTIONS
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALFORNIA

PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
INSTITUTIONAL CONTROLS		
Deed Restrictions	Issued for property w/in potentially contaminated areas to restrict land or groundwater use.	Potentially applicable. Part of Parcel final action.
Access Controls	Fences, signs, etc., installed to limit access to contaminated areas.	Potentially applicable.
Monitoring	Short- and/or long-term monitoring implemented to record site conditions and contaminant levels.	Potentially applicable. Part of Parcel E final action.
REMOVAL OPTIONS		
Excavation of Soils	Excavate product-affected soils using ordinary construction equipment.	Potentially applicable.
Groundwater Extraction	Remove groundwater using wells or collection trenches.	Not applicable for this removal action. Will be considered in the final action.
Product Extraction from Wells	Recover product by extraction from wells.	Not applicable or effective based on HLA's field work (HLA 1991b).
Product Extraction from Open Excavation	Pump floating product layer using top loading pump system following soils excavation to the water table.	Potentially applicable.
PHYSICAL BARRIER CONTROL OPTIONS		
Slurry Wall	Construct a physical barrier around affected area by trenching and filling with low permeability soil, bentonite and/or cement slurry.	Not applicable. Too difficult to install given the subsurface soil conditions.
Grout Curtain	Grout poured into boreholes and mixed with soil in situ using dual augers, to form an impermeable barrier in the subsurface.	Not applicable. Too difficult to install given the subsurface soil conditions.
Sheet Piling	Steel sheet piling driven vertically into the subsurface along contamination boundary, to provide impermeable subsurface barrier to horizontal flow.	Potentially applicable for containment and to control migration.

FINAL

TABLE 5-1: SCREENING OF PROCESS OPTIONS
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALFORNIA

PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
	***EX SITU* PHYSICAL/CHEMICAL TREATMENT**	
Soil Washing/Thermal Desorption/ Chemical Oxidation/Stabilization	Physical, thermal, and chemical treatment of removed soils. Reduction or fixation of chemicals of concern. Generally replaced in excavation void or recycled off site.	Not applicable for this removal action. Will be considered in the final action.
Oil/Water Separation	Product separated from water by gravity, either in a tank or lagoon. Product is skimmed or vacuum pumped from the water surface by tanker trucks.	Potentially applicable and will be combined with other process options.
	BIOLOGICAL TREATMENT	
Bioremediation (Landfarm/Ex-situ soil)	Biodegradation stimulated by adding nutrients and periodically aerating soil.	Not applicable for this removal action.
Bioremediation (In-situ)	To facilitate microbial growth, nutrients are added using injection wells.	Not applicable. Unreliable due to subsurface soil heterogeneity. May take a very long time.
	***IN SITU* PHYSICAL/CHEMICAL TREATMENT**	
Bioventing/Air Sparging/ Steam Sparging/ Soil-Vapor Extraction	Air flow is induced in subsurface through air injection and/or vacuum, above or below the water surface. Oxygen is increased for biodegradation. Steam may be used to enhance volatilization of organic contaminants.	Not applicable. Unreliable due to subsurface soil heterogeneity and physical characteristics of product.
Thermally/Chemically Augmented Recovery	Hot water and/or surfactant-containing water injected into an aquifer through injection wells; groundwater and product extracted from extraction wells.	Not applicable. Unreliable due to subsurface soil heterogeneity.
	DISPOSAL	
Product Recycling	Product is recovered using vacuum trucks and transported to a recycling facility.	Potentially applicable.
Soil Disposal	Solid nonhazardous wastes are permanently disposed of in a permitted solid waste landfill; solid hazardous wastes are permanently disposed of in a RCRA-permitted landfill.	Potentially applicable.

TABLE 5-1: SCREENING OF PROCESS OPTIONS
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALFORNIA

PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
RESTORATION		
Replace Unaffected Overburden	Segregated clean soil and treated soil are replaced as fill in the excavation.	Potentially applicable.
New Fill	New clean fill is brought in to place in excavation. Treated soils are transported off site.	Potentially applicable.

Notes:

1. Potentially applicable technology process options are shown as shaded.
2. Reference cited: HLA, 1991. Product Recovery Site Characterization Investigation, Former Oil Reclamation Ponds, Site IR-03, Naval Station Treasure Island, Hunters Point Annex, San Francisco, California. May 15.

TABLE 6-1: SUMMARY OF REMOVAL AND CONTROL OPTION EVALUATION
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

	REMOVAL OPTIONS		CONTROL OPTIONS
	Excavate to Water Table	Excavate Below Water Table	Install Sheet Piling Subsurface Barrier
Remove Product	0	+	—
Reduce Potential Product Mobility	0	+	+
Implementability	+	0	+
Cost	$$	$$$$	$

\+ = Relatively Effective or Implementable.
0 = Moderately Effective or Implementable.
— = Not Very Effective or Implementable.
$$$ = Relative Cost.

TABLE 6-2: SUMMARY OF DISPOSAL AND RESTORATION OPTION EVALUATION
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

	DISPOSAL OPTIONS		RESTORATION OPTIONS	
	Offsite Disposal	Product Recycling	Replace Overburden	Place New Fill
Effectiveness	+	+	0	+
Implementability	+	+	+	+
Cost	$$	$	$	$$

+ = Relatively effective or Implementable.
0 = Moderately Effective or Implementable.
– = Not very Effective or Implementable.
$$ = Relative Cost.

TABLE 7-1: ALTERNATIVE TECHNOLOGY COMBINATIONS
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

	Alternative 1	Alternative 2	Alternative 3
Removal Actions			
Excavate to Water Table/Product Extraction from Open Excavation		X	X
Excavate Below Water Table		X	
Control Action			
Sheet Pile Subsurface Barrier	X		X
Disposal Actions			
Off-Site Soil Disposal		X	X
Product Recycling		X	X
Restoration Action			
Backfill with New Fill		X	X

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TABLE 7-2: COMPARATIVE COST ANALYSIS OF ALTERNATIVES
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

	Alternative 1	Alternative 2	Alternative 3
REMOVAL ACTIONS			
Excavate to Water Table/Product Extraction from Open Excavation		782,000	782,000
Excavate Below Water Table		722,000	
CONTROL ACTION			
Sheet Piling Subsurface Barrier	685,000		685,000
Surface replacement with clay/topsoil layers (1)	140,000		
Pre-installation soil sampling (2)	52,000		
DISPOSAL ACTIONS			
Off-Site Soil Disposal (excavation to the water table)		1,404,000	1,404,000
Off-Site Soil Disposal (excavation below the water table)		2,059,000	
Product Recycling		69,000	69,000
RESTORATION ACTION			
Backfill with New Fill (3)		1,512,000	710,000
TOTAL COST:	**$877,000**	**$6,548,000**	**$3,650,000**

NOTES:

Detailed costs are presented in Appendix A.

(1) Costs derived from elements in Table A-7 plus $25,000 for grading.

(2) Costs derived from elements in Tables A-1 and A-2.

(3) Backfill costs include replacement of approximately 27,000 cubic yards of clean overburden.

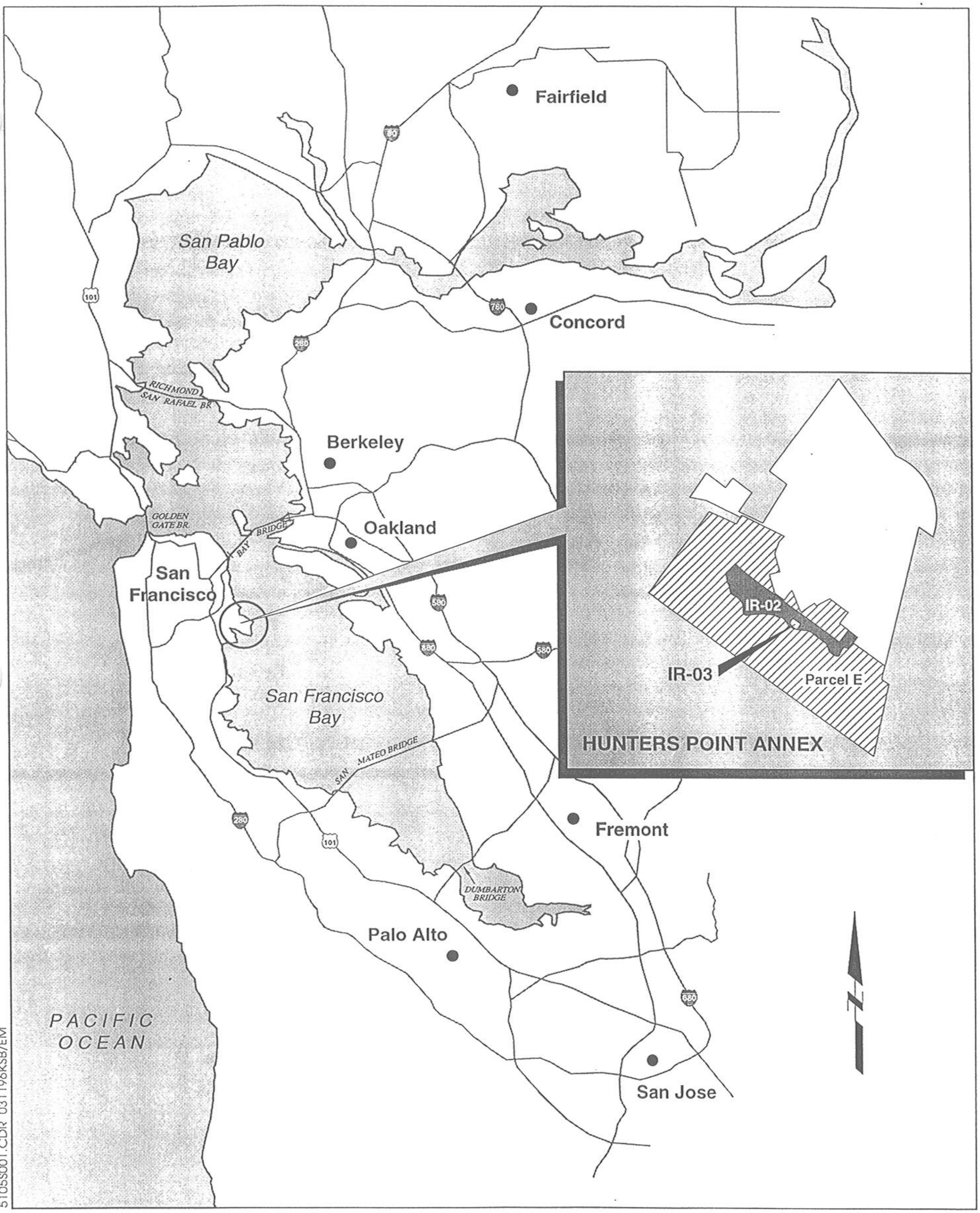
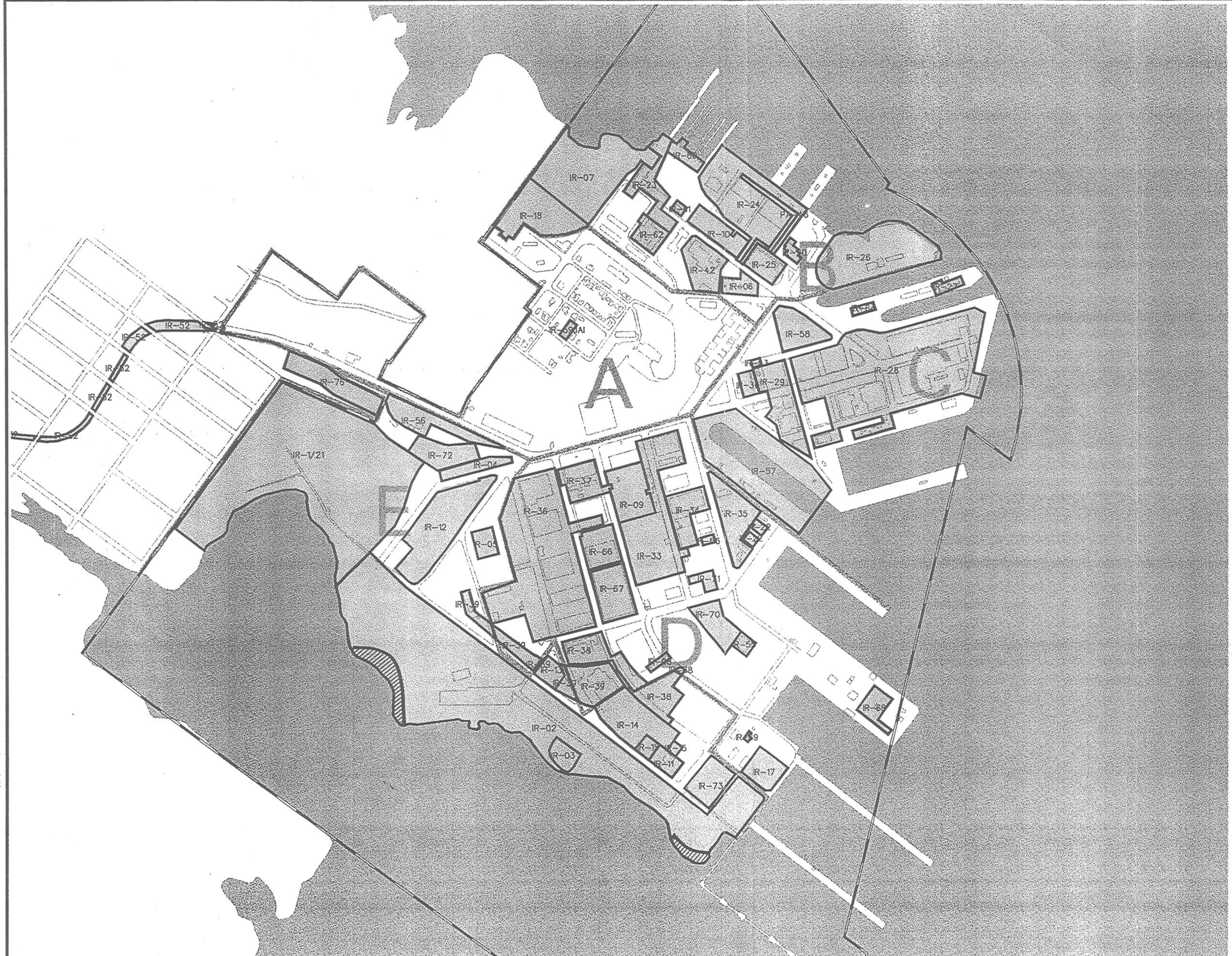


Figure 1-1 : HUNTERS POINT ANNEX IR-03 VICINITY MAP



LEGEND

999 BUILDING NUMBERS

PARCEL BOUNDARIES

BASE BOUNDARY

IR SITES

WETLAND AREAS IN THE VICINITY OF IR-03

400 0 400 800

SCALE: 1" = 800'

SOURCE:
PRC ENVIRONMENTAL MANAGEMENT, INC., EE/CA SITE IR-1/21 DATED MARCH 13, 1996

Figure 1-2 :
HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA
SITE IR-03 EE/CA
FACILITY IR SITES

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11/03/95 /data0/hunters/amis/byptg0.map PRR

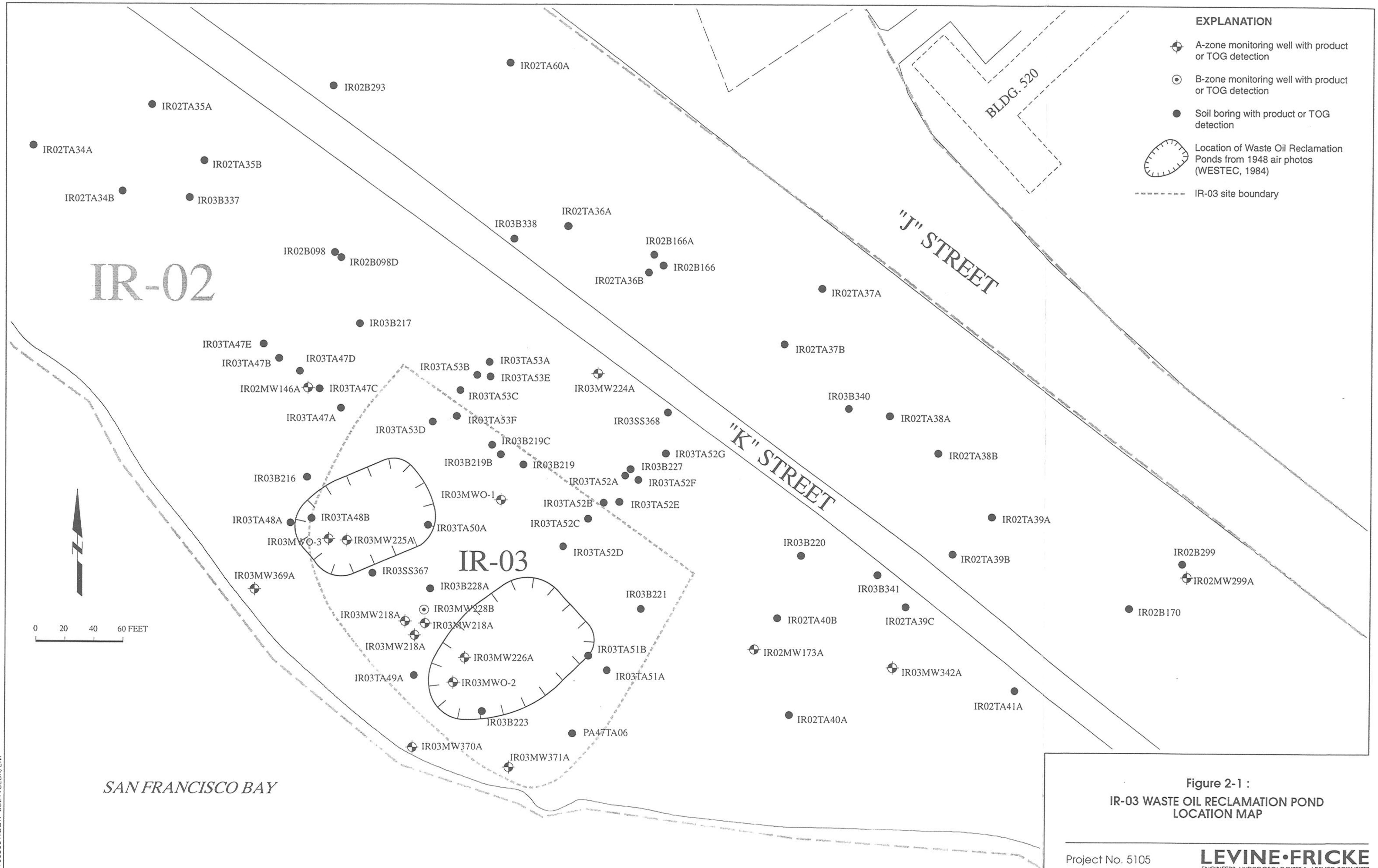

Figure 2-1 :
IR-03 WASTE OIL RECLAMATION POND LOCATION MAP

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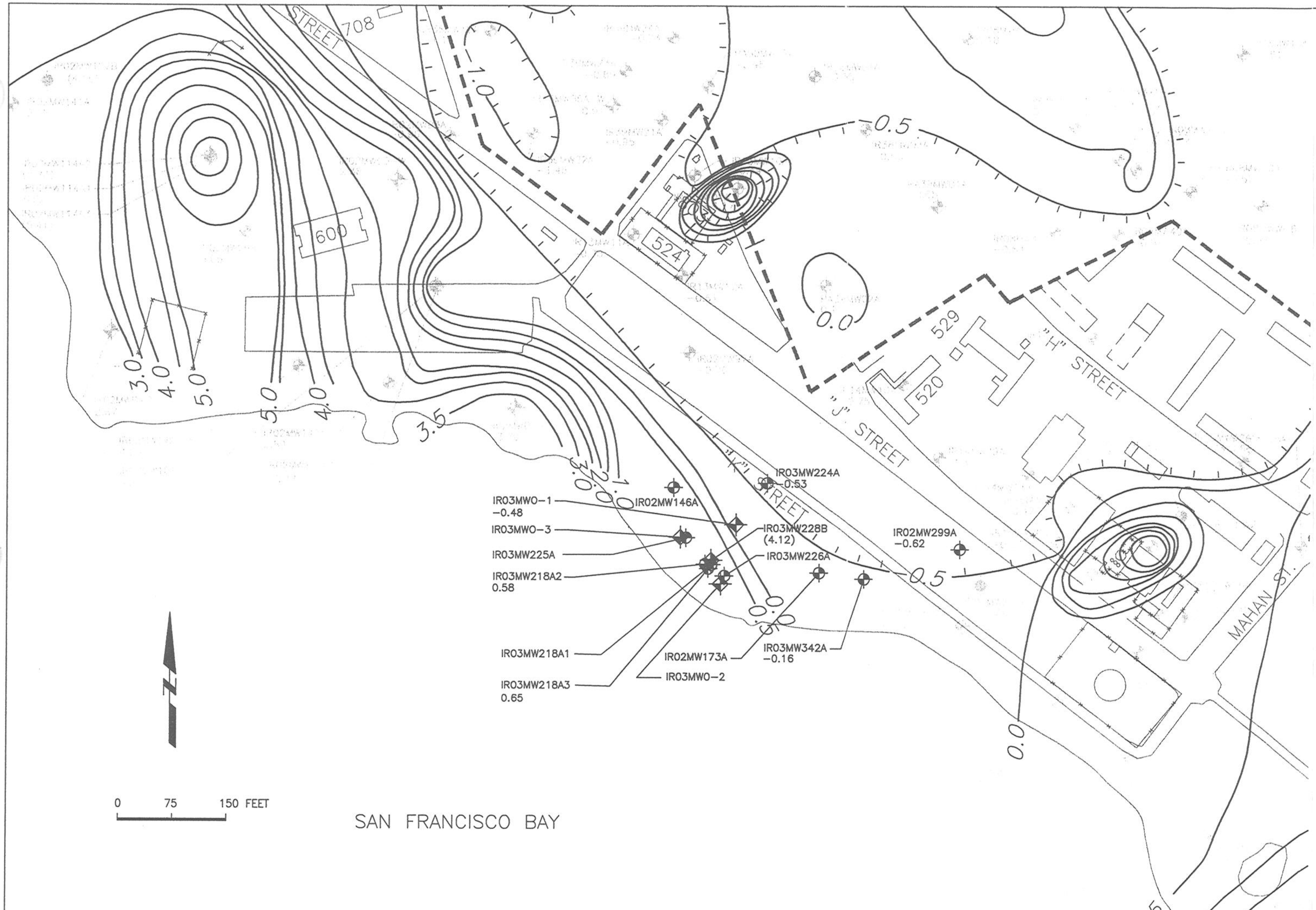

NOTES:

1) WATER-LEVELS WERE MEASURED MAY 22, 1995.

2) BECAUSE FACILTY-WIDE GROUNDWATER LEVELS WERE TAKEN OVER A 7-HOUR PERIOD, GROUNDWATER CONTOURS MAY BE AFFECTED IN AREAS WITH TIDAL INFLUENCE.

ADOPTED FROM: FINAL FACILITY-WIDE GROUNDWATER MONITORING PLAN, HUNTERS POINT ANNEX. SAN FRANCISCO, CALIFORNIA. PRC, APRIL 5, 1996

J:\ENGCAD\5105\IR3-NEW

LEGEND

PA/SI/RI WELLS

- A-AQUIFER MONITORING WELL
- B-AQUIFER MONITORING WELL
- BEDROCK MONITORING WELL
- PIEZOMETER

PRE-PA MONITORING WELLS

- A-AQUIFER MONITORING WELL
- BEDROCK MONITORING WELL
- PARCEL BOUNDARY
- FACILITY BOUNDARY
- LOCATION OF EXISTING BUILDING
- LOCATION OF FORMER BUILDING
- FENCE
- RAILROAD TRACK
- 3.5 WATER-LEVEL ELEVATION CONTOUR (FEET ABOVE MSL) (CONTOUR INTERVAL = 0.5 foot)
- -1.0 WATER-LEVEL ELEVATION CONTOUR (FEET BELOW MSL)
- 2.49 GROUNDWATER ELEVATION (FEET ABOVE MSL) MEASURED MAY 22, 1995
- (5.23) GROUNDWATER ELEVATION NOT USED IN CONTOURING (FEET ABOVE MSL)
- PA PRELIMINARY ASSESSMENT
- SI SITE INVESTIGATION
- RI REMEDIAL INVESTIGATION

Figure 2-2
GROUNDWATER LEVEL
ELEVATION CONTOUR MAP, IR-03 VICINITY
A-AQUIFER
MAY 1995

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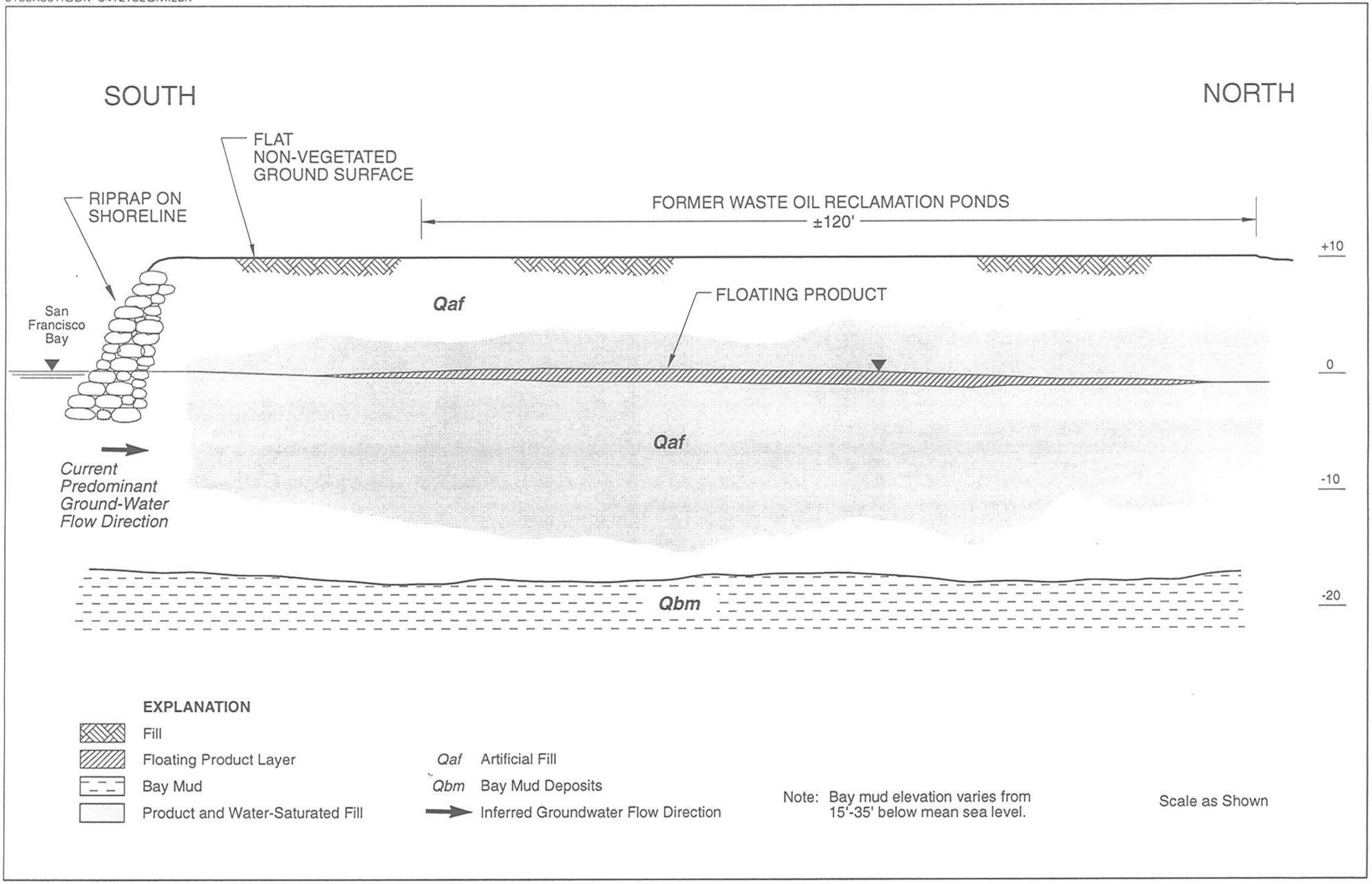

Figure 3-1 : CONCEPTUAL MODEL OF IR-03

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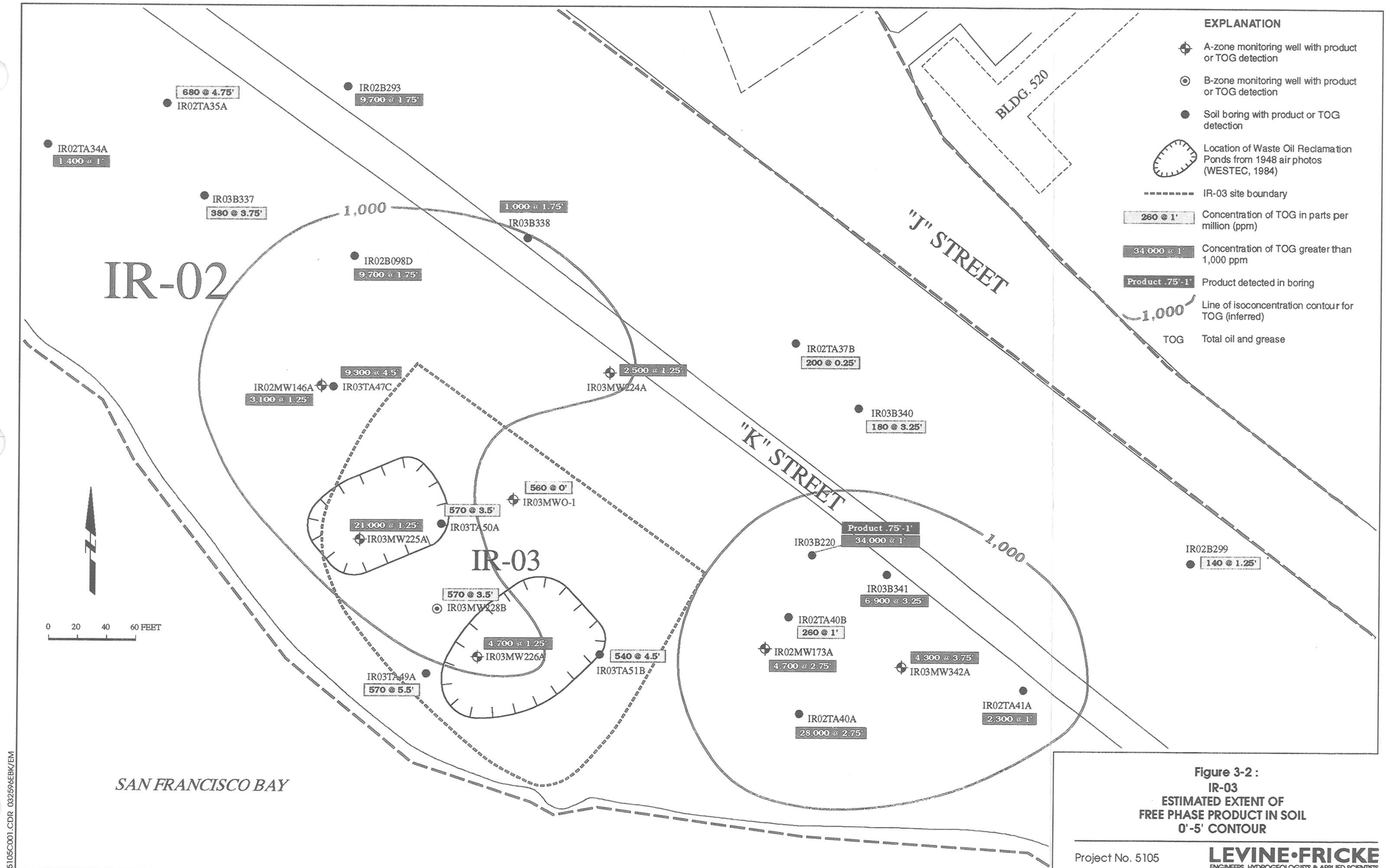

Figure 3-2 :
IR-03
ESTIMATED EXTENT OF FREE PHASE PRODUCT IN SOIL 0'-5' CONTOUR

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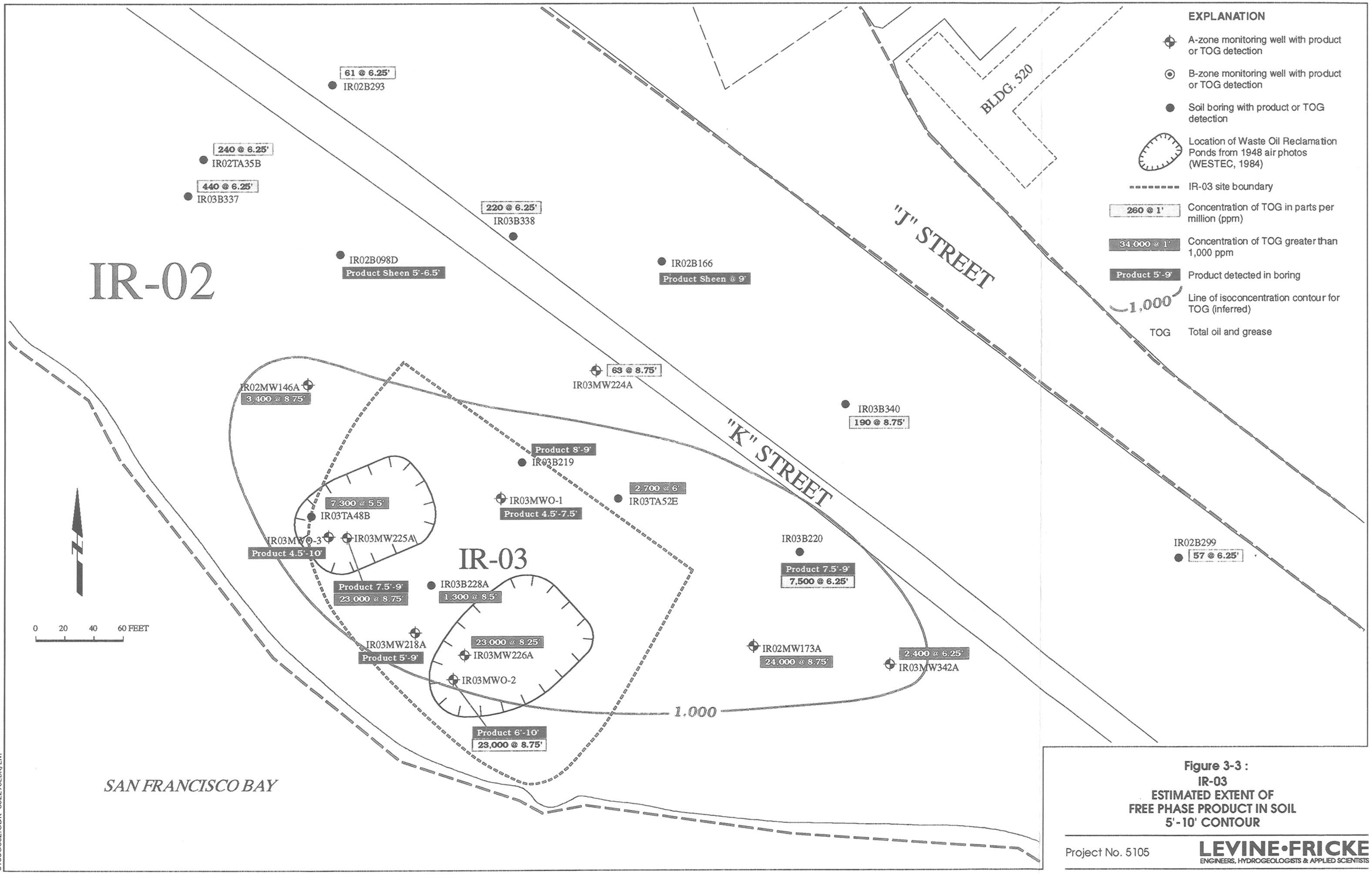

Figure 3-3 :
IR-03
ESTIMATED EXTENT OF FREE PHASE PRODUCT IN SOIL 5'-10' CONTOUR

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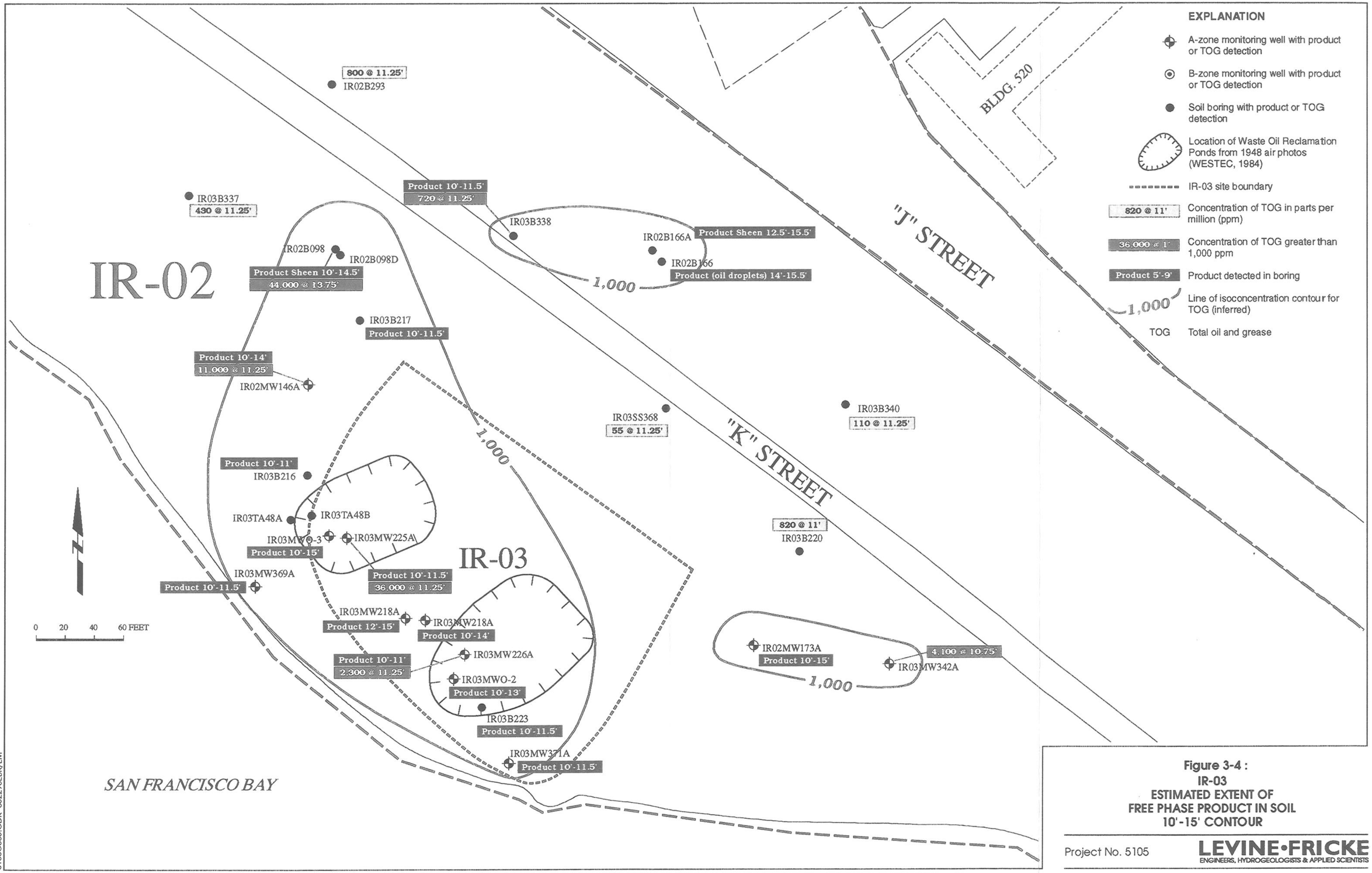

Figure 3-4 :
IR-03
ESTIMATED EXTENT OF FREE PHASE PRODUCT IN SOIL 10'-15' CONTOUR

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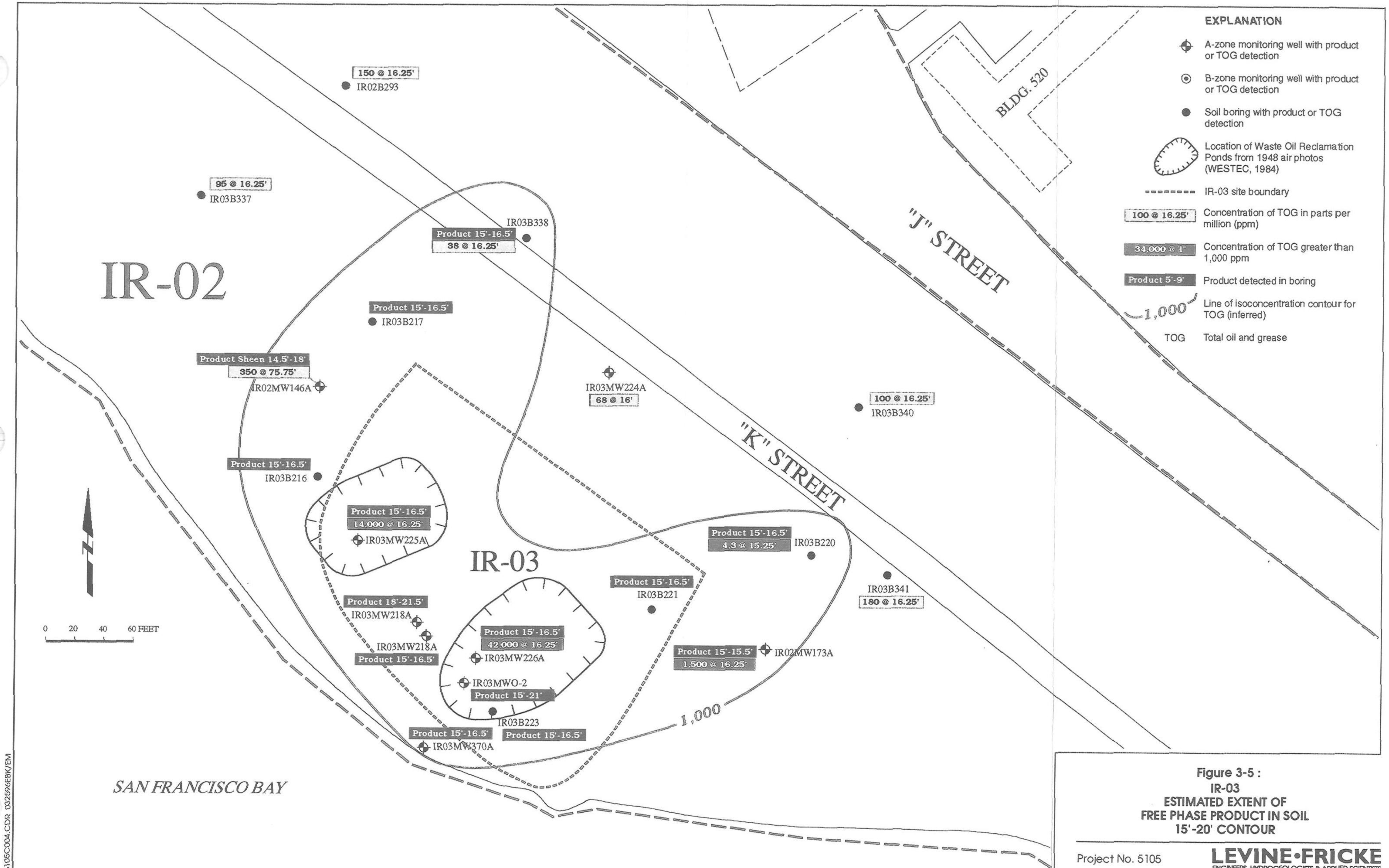

Figure 3-5 :
IR-03
ESTIMATED EXTENT OF FREE PHASE PRODUCT IN SOIL 15'-20' CONTOUR

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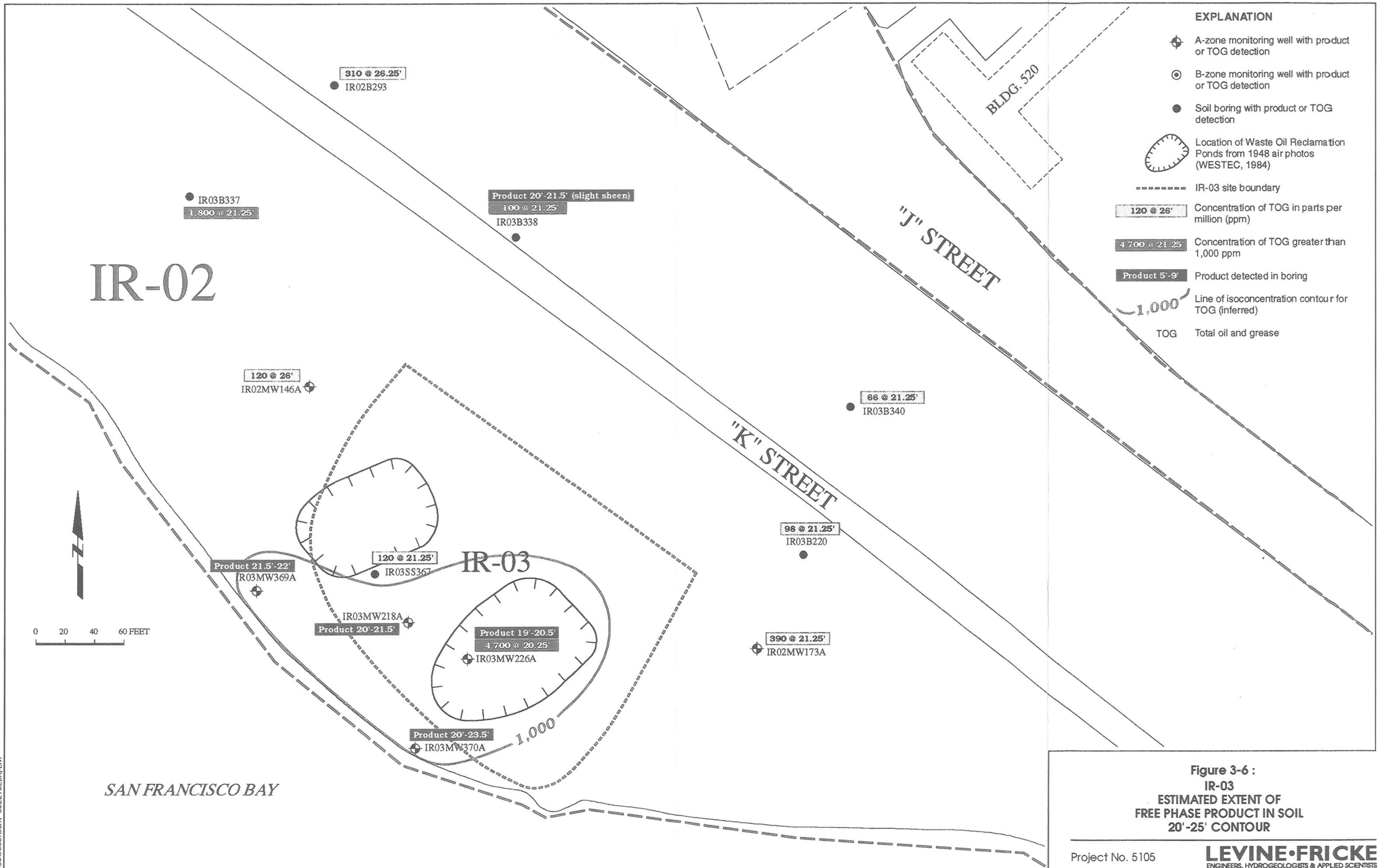

Figure 3-6 :
IR-03
ESTIMATED EXTENT OF
FREE PHASE PRODUCT IN SOIL
20'-25' CONTOUR

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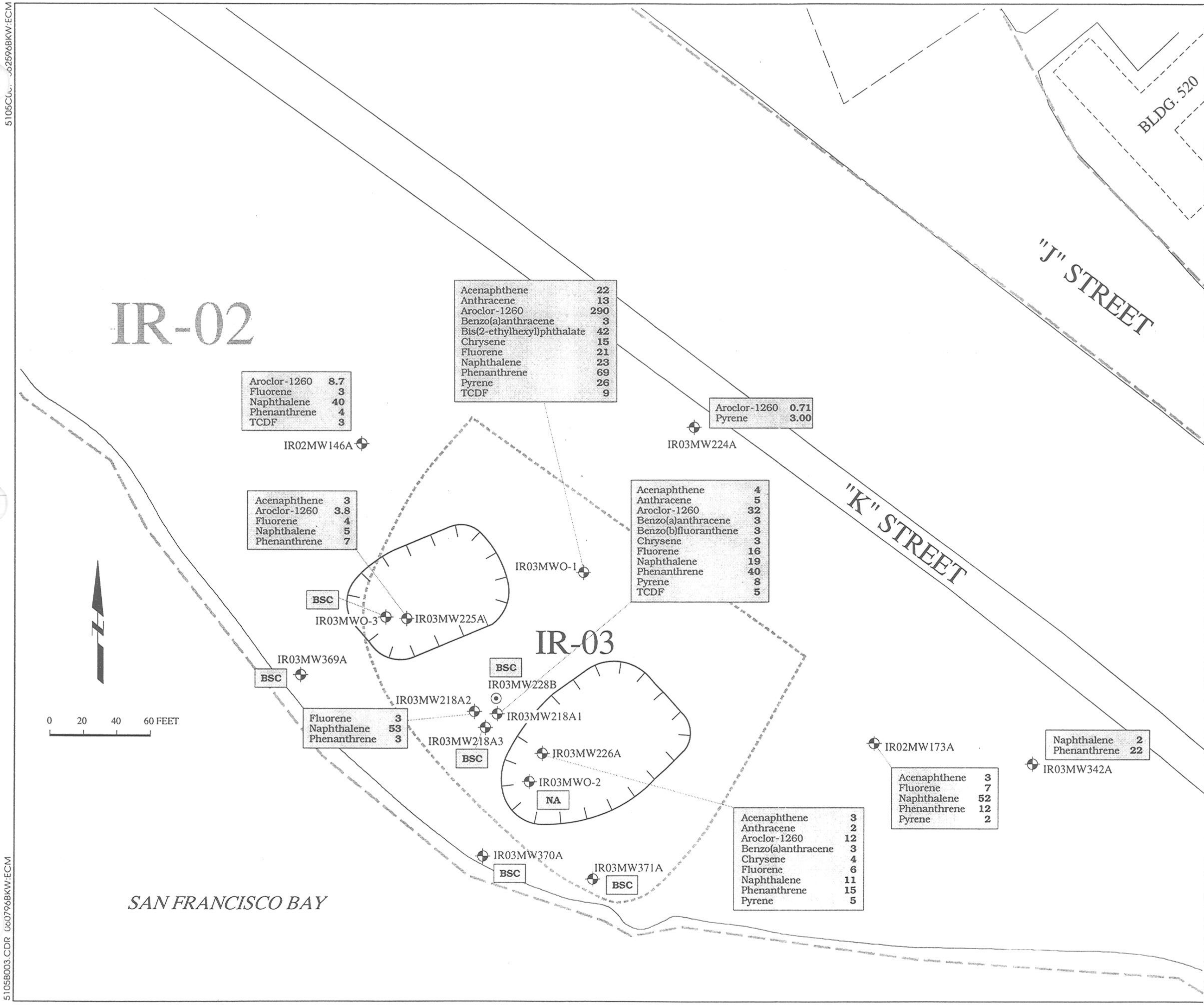

EXPLANATION

A-zone monitoring well

B-zone monitoring well

Location of Waste Oil Reclamation Ponds from 1948 air photos (WESTEC, 1984)

IR-03 site boundary

Chemical Compounds	Screening Criteria (1)(2)	
	Bay and Estuary Plan Human Health (ug/L)	Bay and Estuary Plan Aquatic Life (ug/L)
Acenaphthene	0.013	-
Anthracene	0.013	-
Aroclor-1260	0.00007	0.03
Benzo(a) anthracene	0.013	-
Benzo(b) fluoranthene	0.013	-
Bis(2-ethylhexyl)phthalate	9.9	-
Chrysene	0.013	-
Fluorene	0.013	-
Naphthalene	0.013	-
Phenanthrene	0.031	-
Pyrene	0.031	-
TCDF	0.014EE-12	-

Aroclor-1260 290
Chrysene 42

Concentrations in ug/L

Chemical compound

BSC Below Screening Criteria

NA Not Analyzed

NOTES:

(1) The most stringent of water-quality objectives for protection of human health and aquatic life in the Enclosed Bay and Estuary Plan (SWRCB 1993)

(2) Only compounds that have Bay and Estuary Plan screening data are shown

Figure 3-7 :

MAXIMUM ORGANIC CONCENTRATIONS ABOVE SCREENING CRITERIA IN GROUNDWATER IR-03 EE/CA HUNTERS POINT ANNEX

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5105C0...2596BKW:ECM

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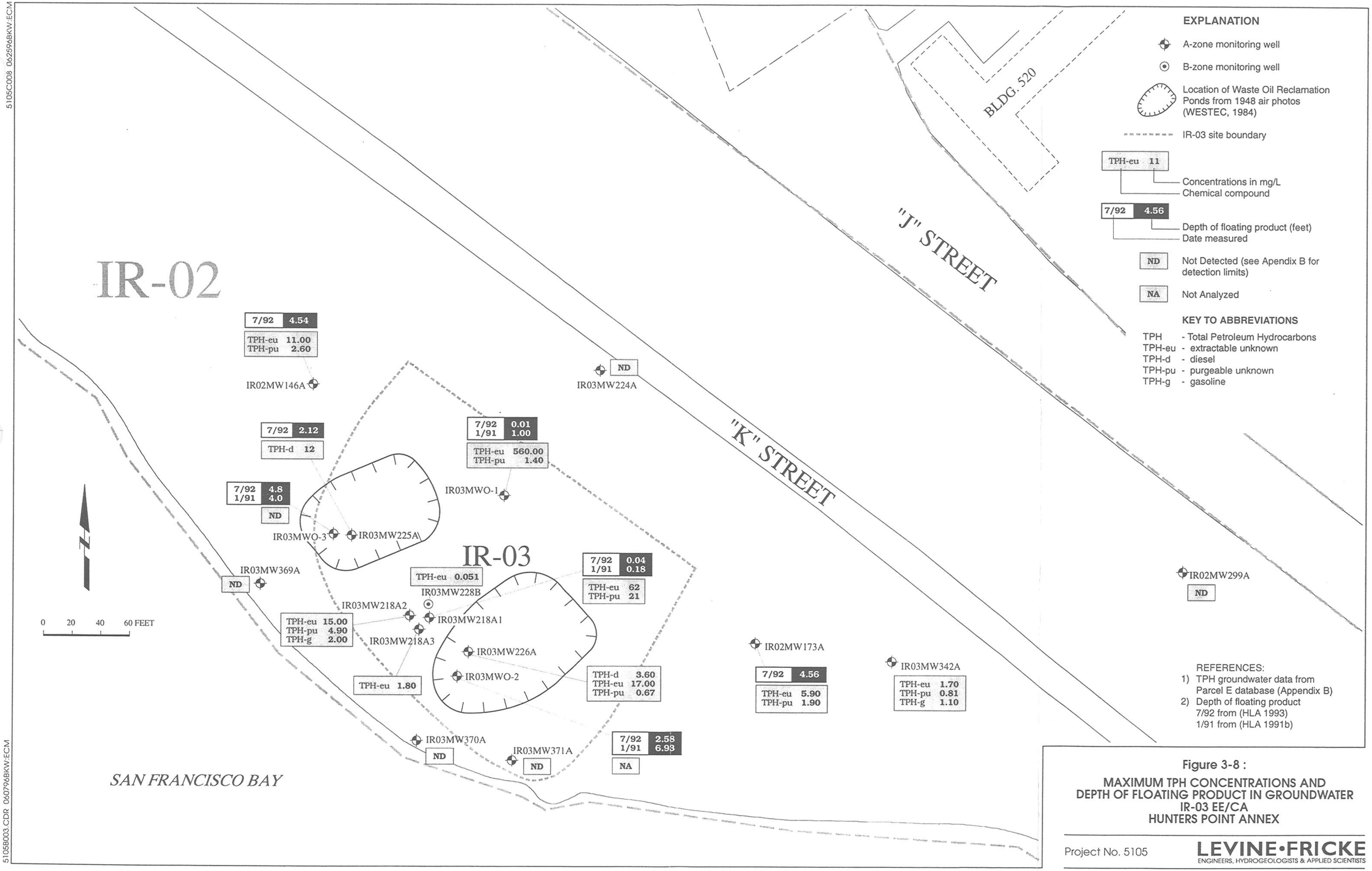
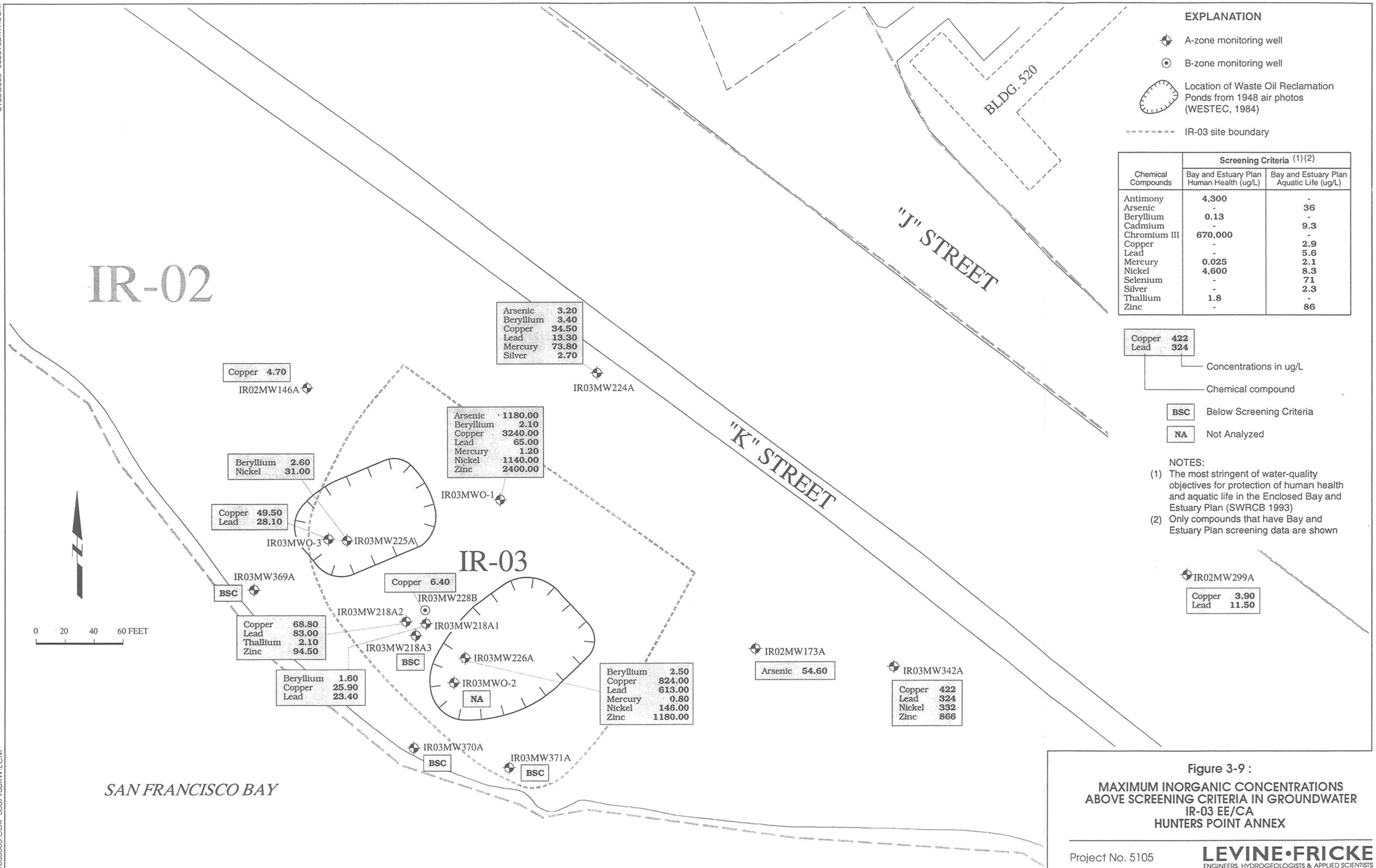


Figure 3-8 :

MAXIMUM TPH CONCENTRATIONS AND DEPTH OF FLOATING PRODUCT IN GROUNDWATER IR-03 EE/CA HUNTERS POINT ANNEX



Chemical Compounds	Screening Criteria (1)(2): Bay and Estuary Plan Human Health (ug/L)	Bay and Estuary Plan Aquatic Life (ug/L)
Antimony	4,300	-
Arsenic	-	36
Beryllium	0.13	-
Cadmium	-	9.3
Chromium III	670,000	-
Copper	-	2.9
Lead	-	5.6
Mercury	0.025	2.1
Nickel	4,600	8.3
Selenium	-	71
Silver	-	2.3
Thallium	1.8	-
Zinc	-	86

Figure 3-9 :
MAXIMUM INORGANIC CONCENTRATIONS ABOVE SCREENING CRITERIA IN GROUNDWATER
IR-03 EE/CA
HUNTERS POINT ANNEX

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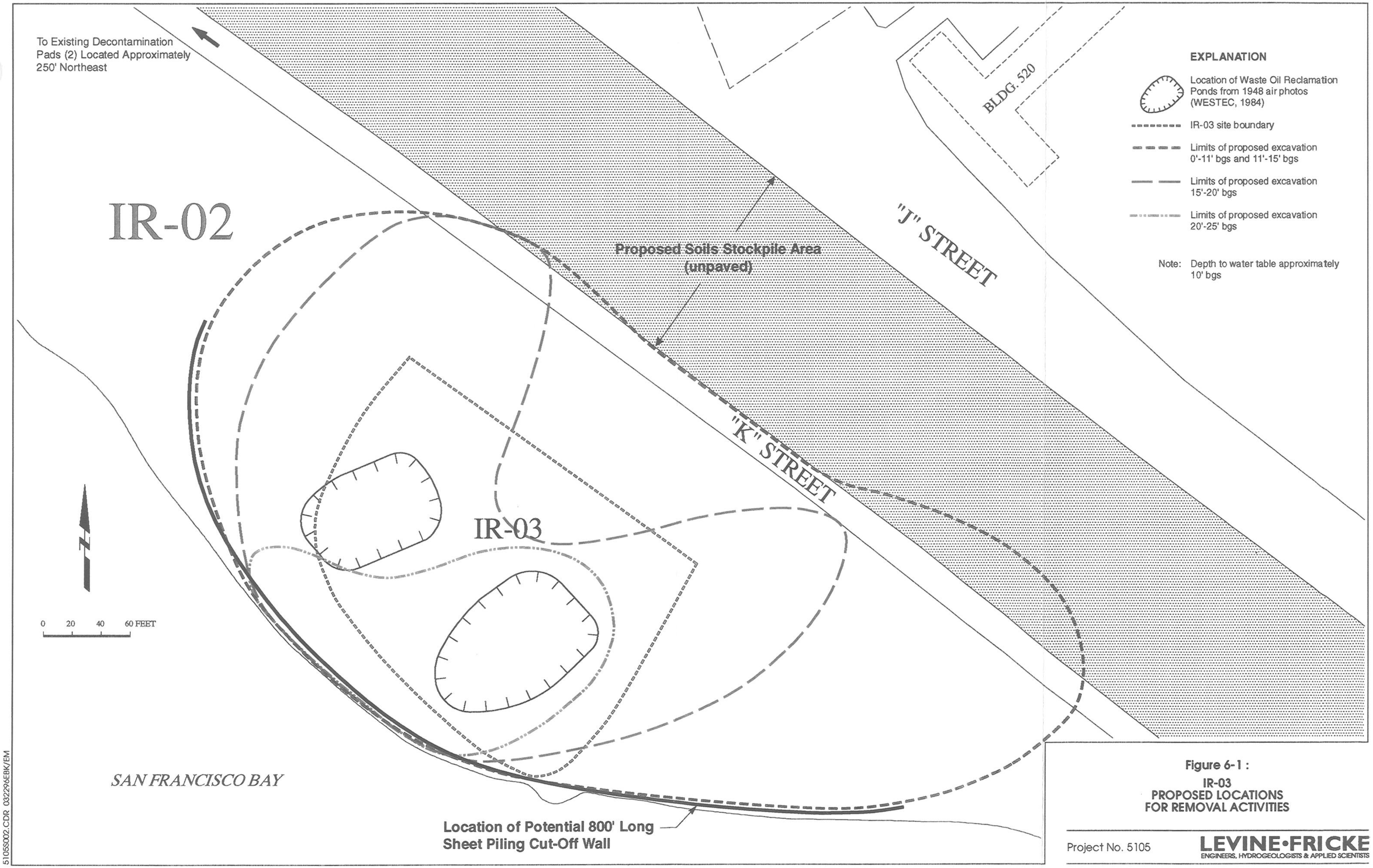

Figure 6-1 :
IR-03
PROPOSED LOCATIONS FOR REMOVAL ACTIVITIES

Project No. 5105

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APPENDIX A

DETAILED COST ESTIMATES

APPENDIX A
GENERAL ASSUMPTIONS USED IN ESTIMATING COSTS
ENGINEERING EVALUATION/COST ANALYSIS - IR-03
HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

- The costs presented are for comparison purposes only and are intended to have an estimated accuracy of only +50 percent to -30 percent (CERCLA Feasibility Study Criteria). Many design variables and permitting requirements have not been established. Construction cost estimates will be refined after system design is complete. A contingency of 20 percent of direct costs is included in these estimates to reflect the engineering uncertainty.

- Estimated costs for excavation, backfilling, disposal, and soil transportation and activities (all other direct costs) assume that the Navy will contract with the RAC contractor directly.

- No provisions for groundwater treatment other than oil/water separation of fluids collected in the stockpile area are included in these cost estimates. Any encountered fluids that may be incidentally removed during excavation operations will be collected in the stockpile area and routed through an oil/water separator before they flow back into the excavation.

- For purposes of this EE/CA, preliminary shoring costs have been developed. The estimated costs for 800 lineal feet of sheet piling (to 27 feet bgs) adjacent to the shoreline (required for soils excavation from ground surface to 11 feet bgs) are included within Table A-3. If excavating to 25 feet bgs, 800' of panel excavation is required along the shoreline in lieu of shoring. Panel excavation costs have been included within Table A-2.

- Pre-excavation sampling for the excavation options will comprise a two-week characterization program assuming up to 200 analytical samples. Samples will be analyzed for TPH, TOG, PCBs, and metals. TPH and TOG will be the indicator analytes of interest combined with visual observations of stained soils, to determine the limits of soil excavation.

- Following excavation activities (for either excavation option) to the depth of the existijng water table and to the limits set by pre-excavation sampling or visual product observations, sidewall sampling will be performed at 100-foot intervals to characterize soils that are left in place. Samples will be collected at depths just above the existing water table and be analyzed for TPH, TOG, PCBs, and metals.

- In general, soil stockpile sampling will comprise analytical testing for TPH, PCBs, and metals, based on one composite sample for each 100 cubic yards to determine unaffected overburden quantity acceptable for replacement in excavation. Off-site soil disposal has a requirement of one TPH analysis for every 50 cubic yards and one metals analysis for each 500 cubic yards.

- A 1-foot buffer layer of top soil will be placed over any overburden replaced in the excavation. Any excess clean overburden will be disposed of at the IR-1/21 industrial landfill for use as a foundation layer.

APPENDIX A
GENERAL ASSUMPTIONS USED IN ESTIMATING COSTS
HUNTERS POINT ANNEX - IR-03
SAN FRANCISCO, CALIFORNIA

The estimated volume of unsaturated soil if excavated to the water table is 54,000 cubic yards, based on a conservative footprint area, assuming the 0- to 5-foot-bgs isoconcentration contour is representative of affected soil to 11 feet bgs. Costs assume that 50 percent of the unsaturated soil (27,000 cubic yards) will be sampled, verified as acceptable, and backfilled in the excavation. Therefore, 27,000 cubic yards will require off-site disposal.

- The estimated volume of saturated soil excavated from the water table elevation to 25 feet bgs is 38,500 cubic yards. This assumes that the footprint area for the 0- to 5-foot-bgs isoconcentration contour is applicable from 11- to 15-feet-bgs. Each isoconcentration contour is used for the respective 5-foot interval to the total depth of 25 feet bgs. For example, the footprint area derived from the 15- to 20-foot-bgs isoconcentration contour is used in the 15- to 20-foot-bgs volume calculation.

- The estimated volume of recoverable (semi-mobile) floating product from the open excavation is 40,000 gallons. This volume is based on preliminary product thickness data and assumed soil properties.

- A density of 1.45 tons per cubic yard of soil has been used in these cost estimates.

- Levine·Fricke assumes standard turnaround time for analytical costs.

- Levine·Fricke assumes that two existing concrete decontamination pads and a 3.5-acre soil storage area are available directly adjacent to site. It is also assumed that clean soil is available adjacent to the Site for berming material.

- It is assumed that an imported fill source is located within 10 miles of the Site.

- Analytical sampling for recycling of recovered floating product will be one sample for each 1,000-gallon frequency. Analytes are anticipated to be metals, PCBs, and SVOCs but may vary depending upon initial characterization and the recycling facility's requirements.

- Engineering design and planning cost estimates depend on technical complexity and the range of direct cost as shown below:
  5 percent for options with low complexity
  8 percent of direct costs > $1,000,000 (high complexity)
  10 percent of direct costs < $1,000,000 (high complexity)

- Construction oversight, inspection, management, and testing range with complexity and direct costs as shown below:
  5 percent for options with low complexity
  8 percent of direct costs > $1,000,000 (high complexity)
  10 percent of direct costs < $1,000,000 (high complexity)

- Health and safety and monitoring are assumed to be 2 percent of direct costs with permitting fees estimated at 5 percent of direct costs.

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TABLE A-1: ESTIMATED COSTS FOR EXCAVATION TO THE WATER TABLE
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

Item	Quantity	Unit	$/Unit	Sub-Total	Total Costs
DIRECT COSTS					
Mobilization:					
contractor mob/demob	1	item	8,000	8,000	
utility clearance/survey	1	item	1,000	1,000	
surveying	1	item	10,000	10,000	
project signs	2	item	500	1,000	
warning signs	10	item	125	1,250	
well protection	4	wells	750	3,000	
well abandonment	7	wells	2,000	14,000	
temporary fencing	1,600	lineal feet	5.0	8,000	
Storage Area Prep:					
berming	3,200	lineal feet	3.5	11,200	
lining	152,500	square foot	1	152,500	
collection trenches	1,500	lineal feet	6	9,000	
Removal:					
excavation & stockpiling (*)	54,000	cubic yards	3.7	199,800	
product extraction and temp. storage	40,000	gallons	0.2	8,000	
dust control	4	weeks	3,000	12,000	
safety equipment (PPE, FID)	4	weeks	1,100	4,400	
Sampling:					
drill rig, personnel & equipment (pre-excavation)	2	weeks	5,000	10,000	
analytical costs (pre-excavation)	200	samples	100	20,000	
field personnel (pre-excavation)	90	hours	50	4,500	
analytical costs (overburden stockpile)	270	samples	200	54,000	
TOTAL: DIRECT COSTS					$532,000
INDIRECT COSTS					
engineering design and planning	0.10	total direct		53,200	
construction inspection, management and testing	0.10	total direct		53,200	
permitting	0.05	total direct		26,600	
health, safety & monitoring	0.02	total direct		10,640	
contingency	0.20	total direct		106,400	
TOTAL: INDIRECT COSTS					$250,000
TOTAL COSTS: DIRECT + INDIRECT					**$782,000**

(*) Does not include sheet pile shoring costs (see Table A-3).

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TABLE A-2: ESTIMATED COSTS FOR EXCAVATION BELOW THE WATER TABLE
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

Item	Quantity	Unit	$/Unit	Sub-Total	Total Costs
DIRECT COSTS					
Mobilization:					
contractor mob/demob	1	item	8,000	8,000	
surveying	1	item	10,000	10,000	
well protection	4	wells	750	3,000	
Removal:					
excavation & stockpiling (*)	38,500	cubic yards	5.2	200,200	
shoring	12,000	square feet	18	216,000	
dust control	9	weeks	3,000	27,000	
safety equipment (PPE, FID)	9	weeks	1,100	9,900	
Pre-excavation Sampling:					
drill rig personnel & equipment	1	weeks	5,000	5,000	
analytical costs	100	samples	100	10,000	
field personnel	45	hours	50	2,250	
TOTAL: DIRECT COSTS					$491,000
INDIRECT COSTS					
engineering design and planning	0.10	total direct		49,100	
construction inspection, management and testing	0.10	total direct		49,100	
permitting	0.05	total direct		24,550	
health, safety & monitoring	0.02	total direct		9,820	
contingency	0.20	total direct		98,200	
TOTAL: INDIRECT COSTS					$231,000
TOTAL COSTS: DIRECT + INDIRECT					**$722,000**

(*) Includes costs for dragline excavation techniques (11' to 25' bgs), and 800 feet of panel excavation from 0 to 11' bgs.

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TABLE A-3: ESTIMATED COSTS FOR SHEET PILING SUBSURFACE BARRIER INSTALLATION
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

Item	Quantity	Unit	$/Unit	Sub-Total	Total Costs
DIRECT COSTS					
Mobilization:					
contractor mob/demob	1	item	8,500	8,500	
project signs	2	item	500	1,000	
warning signs	10	item	125	1,250	
well protection	3	wells	750	2,250	
temporary fencing	1,600	lineal feet	5	8,000	
Installation:					
drill rig personnel & equipment	16	boring	240	3,840	
field personnel	44	hour	50	2,200	
truck	50	day	50	2,500	
sheet piling subsurface barrier installation (to 27 feet bgs)	21,600	square feet	20	432,000	
safety equipment (PPE, FID)	4	weeks	1,100	4,400	
TOTAL: DIRECT COSTS					$466,000
INDIRECT COSTS					
engineering design and planning	0.10	total direct		46,600	
construction inspection, management and testing	0.10	total direct		46,600	
permitting	0.05	total direct		23,300	
health, safety & monitoring	0.02	total direct		9,320	
contingency	0.20	total direct		93,200	
TOTAL: INDIRECT COSTS					$219,000
TOTAL COSTS: DIRECT + INDIRECT					**$685,000**

NOTES:
1. See Table A-7 for line item costs associated with site restoration activities under this option (costs not included here).
2. "Pre-installation" soil sampling costs consist of "pre-excavation" sampling costs included in Tables A-1 and A-2 (costs not included here).

TABLE A-4: ESTIMATED COSTS FOR OFF-SITE SOIL DISPOSAL (EXCAVATION TO THE WATER TABLE - 11' bgs) HUNTERS POINT ANNEX - SITE IR-03 SAN FRANCISCO, CALIFORNIA

Item	Quantity	Unit	$/Unit	Sub-Total	Total Costs
DIRECT COSTS					
Mobilization:					
contractor mob/demob	1	item	4,000	4,000	
Soil Preparation/Sampling:					
stockpile sampling (TRPH)	540	samples	100	54,000	
stockpile sampling (Metals)	54	samples	70	3,780	
Transportation and Disposal:					
loading and transportation	39,215	tons	3.50	137,253	
soil disposal at Class II facility	39,215	tons	20	784,300	
liner disposal at Class III facility	25	tons	14	350	
dust control	10	weeks	3,000	30,000	
safety equipment (PPE, FID)	10	weeks	1,100	11,000	
TOTAL: DIRECT COSTS					$1,025,000
INDIRECT COSTS					
engineering design and planning	0.05	total direct		51,250	
construction inspection, management and testing	0.05	total direct		51,250	
manifesting	0.05	total direct		51,250	
health, safety & monitoring	0.02	total direct		20,500	
contingency	0.20	total direct		205,000	
TOTAL: INDIRECT COSTS					$379,000
TOTAL COSTS: DIRECT + INDIRECT					**$1,404,000**

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TABLE A-5: ESTIMATED COSTS FOR OFF-SITE SOIL DISPOSAL (EXCAVATION BELOW THE WATER TABLE - 25' bgs) HUNTERS POINT ANNEX - SITE IR-03 SAN FRANCISCO, CALIFORNIA

Item	Quantity	Unit	$/Unit	Sub-Total	Total Costs
DIRECT COSTS					
Mobilization:					
contractor mob/demob	1	item	4,000	4,000	
Soil Preparation/Sampling:					
stockpile sampling (TRPH)	770	samples	100	77,000	
stockpile sampling (Metals)	77	samples	70	5,390	
Transportation and Disposal:					
soils drying/aerating	55,810	tons	1	55,810	
loading and transportation	55,810	tons	3.50	195,335	
soil disposal at Class II facility	55,810	tons	20	1,116,200	
liner disposal at Class III facility	25	tons	14	350	
dust control	12	weeks	3,000	36,000	
safety equipment (PPE, FID)	12	weeks	1,100	13,200	
TOTAL: DIRECT COSTS					$1,503,000
INDIRECT COSTS					
engineering design and planning	0.05	total direct		75,150	
construction inspection, management and testing	0.05	total direct		75,150	
manifesting	0.05	total direct		75,150	
health, safety & monitoring	0.02	total direct		30,060	
contingency	0.20	total direct		300,600	
TOTAL: INDIRECT COSTS					$556,000
TOTAL COSTS: DIRECT + INDIRECT					**$2,059,000**

TABLE A-6: ESTIMATED COSTS FOR PRODUCT RECYCLING
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

Item	Quantity	Unit	$/Unit	Sub-Total	Total Costs
DIRECT COSTS					
Mobilization:					
contractor mob/demob	1	item	2,000	2,000	
Soil Preparation/Sampling:					
product sampling	40	samples	150	6,000	
Transportation and Disposal:					
disposal at hazardous waste oil recycler (*)	40,000	gallons	0.99	39,600	
safety equipment (PPE, FID)	2	weeks	1,100	2,200	
TOTAL: DIRECT COSTS					$50,000
INDIRECT COSTS					
engineering design and planning	0.05	total direct		2,500	
construction inspection, management and testing	0.05	total direct		2,500	
manifesting	0.05	total direct		2,500	
health, safety & monitoring	0.02	total direct		1,000	
contingency	0.20	total direct		10,000	
TOTAL: INDIRECT COSTS					$19,000
TOTAL COSTS: DIRECT + INDIRECT					**$69,000**

(*) Includes loading, transportation and disposal

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TABLE A-7: ESTIMATED COSTS FOR BACKFILL WITH NEW FILL
(EXCAVATION TO THE WATER TABLE - 11' bgs)
HUNTERS POINT ANNEX - SITE IR-03
SAN FRANCISCO, CALIFORNIA

Item	Quantity	Unit	$/Unit	Sub-Total	Total Costs
DIRECT COSTS					
Mobilization:					
contractor mob/demob	1	item	8,000	8,000	
surveying	1	item	10,000	10,000	
Restoration:					
clean fill (purchase, place & compact)	20,000	cubic yards	10	200,000	
replace overburden (place & compact)	27,000	cubic yards	5	135,000	
clay layer (1-1.5 ft bgs) (purchase, place & compact) *	2,500	cubic yards	15	37,500	
topsoil (0-1 ft bgs) (purchase, place & compact) *	5,000	cubic yards	15	75,000	
seeding, fertilizing and mulching	2.8	acres	500	1,400	
dust control	4	weeks	3,000	12,000	
safety equipment (PPE, FID)	4	weeks	1,100	4,400	
TOTAL: DIRECT COSTS					$483,000
INDIRECT COSTS					
engineering design and planning	0.10	total direct		48,300	
construction inspection, management and testing	0.10	total direct		48,300	
permitting	0.05	total direct		24,150	
health, safety & monitoring	0.02	total direct		9,660	
contingency	0.20	total direct		96,600	
					$227,000
TOTAL COSTS: DIRECT + INDIRECT					**$710,000**

* Restoration items also associated with sheet pile barrier control option.

TABLE A-8: ESTIMATED COSTS FOR BACKFILL WITH NEW FILL (EXCAVATION BELOW THE WATER TABLE - 25' bgs) HUNTERS POINT ANNEX - SITE IR-03 SAN FRANCISCO, CALIFORNIA

Item	Quantity	Unit	$/Unit	Sub-Total	Total Costs
DIRECT COSTS					
Mobilization:					
contractor mob/demob	1	item	8,000	8,000	
surveying	1	item	10,000	10,000	
Restoration:					
crushed rock (11-25 ft bgs)	55,800	tons	10	558,000	
clean fill (purchase, place & compact)	20,000	cubic yards	10	200,000	
replace overburden (place & compact)	27,000	cubic yards	5	135,000	
clay layer (1 to 1.5 ft bgs) (purchase, place & compact) *	2,500	cubic yards	15	37,500	
topsoil (0-1 ft bgs) (purchase, place & compact) *	5,000	cubic yards	15	75,000	
geotextile fabric	133,000	square feet	0.12	15,960	
seeding, fertilizing and mulching	2.8	acres	500	1,400	
dust control	4	weeks	3,000	12,000	
safety equipment (PPE, FID)	4	weeks	1,100	4,400	
TOTAL: DIRECT COSTS					$1,057,000
INDIRECT COSTS					
engineering design and planning	0.08	total direct		84,560	
construction inspection, management and testing	0.08	total direct		84,560	
permitting	0.05	total direct		52,850	
health, safety & monitoring	0.02	total direct		21,140	
contingency	0.20	total direct		211,400	
TOTAL: INDIRECT COSTS					$455,000
TOTAL COSTS: DIRECT + INDIRECT					**$1,512,000**

* Restoration items also associated with sheet pile barrier control option.

APPENDIX B

BACKGROUND DATA

THIS APPENDIX CONTAINS EXCERPTS FROM

THE UNPUBLISHED INTERNAL WORKING COPY DOCUMENT

"Preliminary Draft

Operable Unit-1 (OU-1) Summary of Remedial Investigation

Naval Station Treasure Island

Hunters Point Annex"

Prepared by: HLA in September 1993

DISCLAIMER

The unpublished preliminary draft report and data for OU-1, prepared by HLA in September 1993, were provided to Levine·Fricke by PRC in 1996. The report was used to obtain descriptions of IR-03 site history, geology, and hydrogeology as well as limited summaries of soil and groundwater data. Data and descriptions were used assuming proper QA/QC was completed. Levine·Fricke did not verify these interpretations against original analytical laboratory reports, field notes, or any other source documents. This is a proper level of effort given the scope of a removal action. Final presentation of this data will be provided in the Parcel E Remedial Investigation.

The database used for the IR-03 EE/CA (Appendix B4) includes all detectable soil and groundwater data provided by PRC up to June 1996, and should contain more data than the unpublished preliminary draft OU-1 report prepared in 1993. The database will be completed and validated in the Remedial Investigation Report for Parcel E.

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B3 Monitoring Well Boring Logs and Well Construction Detail for IR-03 Vicinity

B4 Database for IR-03 Vicinity

Table B4-1: Inorganic Chemicals Detected in Soil and Other Soil Parameters, IR-03 Engineering Evaluation/Cost Analysis HPA (Parcel E Database)

Table B4-2: Organic Chemicals Detected in Soil, IR-03 Engineering Evaluation/Cost Analysis HPA (Parcel E Database)

Table B4-3: Inorganic Chemicals Detected in Groundwater and Other Groundwater Parameters, IR-03 Engineering Evaluation/Cost Analysis HPA (Parcel E Database)

Table B4-4: Organic Chemicals Detected in Groundwater, IR-03 Engineering Evaluation/Cost Analysis HPA (Parcel E Database)

Table B4-5: Chemicals Detected in Oil Samples, IR-03 Engineering Evaluation/Cost Analysis HPA (Parcel E Database)

NOTES TO TABLES

The following explanation apply to the tables includes in Appendix B.

Sampling Location Naming Convention (i.e. IR36MW09A)

IR36 IR Site Number

MW Monitoring Well or Boring

09 Location Number

A	Borings:	Refusal
	Wells:	A = A-aquifer
		B = B-aquifer
		F = Bedrock aquifer

Groundwater samples are collected from monitoring wells after purging.

Explanations of Qualifiers

J* Analytical results are qualified as estimated due to the results of the full Contract Laboratory Program (CLP) validation.

J0 Analytical results are qualified as estimated due to noncompliance with internal standard area count or retention time criteria.

J1 Analytical results are qualified as estimated due to noncompliance with instrument performance criteria.

J2 Analytical results are qualified as estimated due to noncompliance with precision criteria.

J3 Analytical results are qualified as estimated due to noncompliance with spike recovery criteria.

J4 Analytical results are qualified as estimated due to noncompliance with inductively coupled plasma (ICP) serial dilution relative percent difference (RPD) criteria.

J5 Analytical results are qualified as estimated due to noncompliance with holding time criteria.

J6 Analytical results are qualified as estimated due to noncompliance with field duplicate RPD criteria from the quality assurance project plan.

J7	Analytical results are qualified as estimated due to noncompliance with initial and/or continuing calibration criteria.
J8	Analytical results are qualified as estimated due to the presence of the compound above the calibration range.
J9	Analytical results are qualified as estimated due to noncompliance with ICP interference check sample criteria.
V	Analytical results received a full CLP validation.
A	Based on cursory validation, analytical results for this compound are acceptable without qualification.
R	Reporting limit changed due to sample volume limitations.
U	Compound was analyzed but not detected.
J	Result is detected below the reporting limit or is an estimated concentration.
E	Concentration exceeds the calibration range of the gas chromatography/mass spectrometry (GC/MS) instrument for the specific analysis.
D	Compound is identified in an analysis at a secondary dilution factor.
B	Compound is also detected in the laboratory method blank.

B1 - SELECTED TEXT SECTIONS APPLICABLE TO IR-03

3.0 CHARACTERISTICS OF OPERABLE UNIT I

The three sites composing OU I are described below.

3.1 Site Background

3.1.1 Site IR-1/21

The Industrial Landfill, Site IR-1/21, is a 36-acre, horseshoe-shaped area along the southwestern shoreline of HPA (Plates 1 and 2). The area of investigation has extended beyond the IR site boundary to encompass approximately 41 acres. The south and southwestern portions of the site along the margin of San Francisco Bay are generally flat. The rest of the site rises gradually to the north, to a maximum elevation of 22 feet MSL.

The site is unpaved except in the north, along the former alignment of Spear Avenue, and in the northeast, where a large area is covered with concrete. The surface of the concrete is rough and uneven; the concrete was probably placed during past activities by a tenant. The rest of the site is bare soil or covered with seasonal vegetation. The shoreline is locally covered with riprap and assorted rubble such as broken asphalt and bricks.

There are no buildings at Site IR-1/21. Storm runoff flows across the ground surface and into the bay.

The filling history of the Industrial Landfill is not well documented. Aerial photos indicate that filling of the bay on the east side of the site began in the 1940s. Review of aerial photographs indicates that Artificial Fill, which is composed primarily of serpentinite, was placed on native bay sediments during bay filling operations from 1942 to 1946. The west side of the site was filled primarily during the 1950s. A wide slough extended from the bay to the north corner of the site; between 1958 and 1974, the Navy filled this slough area with shipyard wastes, including construction and industrial debris and waste, sandblast waste, domestic refuse, paints, solvents, and radioactive waste (*WESTEC, 1984*). Filling of the slough was completed by 1974 and the entire site was capped with several feet of clean fill.

Wastes disposed in the Industrial Landfill total an estimated 1 million cubic yards of solid material. Included in the wastes were an estimated 235,000 tons of sandblast waste, 500 cubic yards of asbestos, 6,000 pounds of fluorescent radium dials and knobs, 13,000 gallons of paint sludges, and 8,000 gallons of solvents and waste oils (*WESTEC, 1984*).

As discussed in Section 1.3, Triple A Machine Shop occupied HPA from May 1976 through June 1986. Triple A Sites 1 and 16 are within the Industrial Landfill (Plate 2). During Triple A's occupancy, unlabeled drums were stored at Triple A Site 1 for an unknown period of time. Ground staining was observed in the vicinity of the drums and they were later removed by Triple A (*DA, 1986*). Industrial debris and sandblast waste were disposed at Triple A Site 16 on the shoreline adjacent to the south access road (Plate 2).

3.1.2 Site IR-2

The Bay Fill Area, Site IR-2, is southeast of the Industrial Landfill and comprises most of the south shoreline area of HPA (Plates 1, 3, 4, and 5). It is a long, narrow area of approximately 46 acres. The site is flat with surface elevations generally less than 12 feet MSL. The shore of the bay is sandy and covered locally with riprap and other debris.

Building 600 and Tank S-505 are the only structures within Site IR-2. The roads, parking lot at Building 600, and southeast end of the site near Berth 36 are paved.

The remainder of the site is unpaved. Storm runoff collects in the storm drain system or runs off directly into the bay.

Site IR-2 was filled in approximately the same manner as the early filling at Site IR-1/21. From 1945 to 1978, the south shoreline of HPA was used as a site for disposal of sandblast waste, paint scrapings, and other debris. Triple A Machine Shop disposed of a variety of wastes at the site including:

- industrial debris, drums, paint cans, pipe lagging, and asphalt (Triple A Sites 2, 14, and 18)
- sandblast and liquid wastes (Triple A Site 17, which also covers Site IR-3)
- waste oil containing PCBs (Triple A Site 13)
- oil and other liquids (Triple A Site 19).

Triple A sites are shown on Plates 3, 4, and 5.

3.1.3 Site IR-3

Site IR-3, the Oil Reclamation Ponds, is in the eastern part of the southern shoreline and is completely surrounded by Site IR-2 (Plates 1 and 4). It is a small, semirectangular area of less than 1 acre. The total area of investigation extended into adjacent Site IR-2 encompassing approximately 5 acres.

No buildings are present onsite; the area is unpaved and generally devoid of vegetation. Concrete covers the shoreline in the area that was immediately adjacent to the Oil Reclamation Ponds. Storm runoff runs directly into the bay or collects in the storm drain system.

The Navy operated two oil reclamation ponds on the south shore of HPA from 1944 to 1974. The ponds were unlined and were constructed in fill material approximately 30 feet from the shoreline. Oily wastes generated from ships and from other shipyard operations were hauled by truck or were pumped through a pipeline from Berth 29 and disposed in the ponds. The liquid was heated using subsurface steam pipes to facilitate oil/water separation, and the water drawn off during the process was discharged to the bay. The reclaimed oil was removed about three times a year by a private contractor, who sold much of it for road oil. The Initial Assessment Study (IAS) estimated that about 0.6 to 2.0 millions gallons of waste was received annually at the Oil Reclamation Ponds (*WESTEC, 1984*). WESTEC reported that one pond was 50 by 60 feet wide by 5 feet deep with a capacity of 190,000 gallons and the other was 55 by 100 feet wide by 5 feet deep with a capacity of 250,000 gallons. The ponds were filled by the Navy in 1974. There is no indication that the underlying oily soil was treated or removed prior to filling.

Triple A Site 17, where sandblast and liquid wastes were disposed, covers all of Site IR-3 and a portion of adjoining Site IR-2 (Plate 4). Ground staining is still present in some areas.

3.2 Previous Investigations

Sites IR-1/21, IR-2, and IR-3 were previously investigated by EMCON Associates to evaluate areas of potential soil and groundwater contamination identified in the IAS (*EMCON Associates, 1987a*). EMCON drilled 9 borings and completed all as monitoring wells at Site IR-1/21, 17 borings and completed 5 as monitoring wells at Site IR-2, and 5 borings and completed 3 as monitoring wells at Site IR-3. Total depths of the borings and wells ranged from 11.5 to 34.5 feet. Approximately three soil samples were collected from each boring and groundwater samples were collected from the wells. Soil and groundwater samples were analyzed for volatile organic compounds

(VOCs), polyaromatic hydrocarbons (PAHs), and metals; the groundwater samples were also analyzed for phenols and gross alpha and beta radiation.

At Site IR-1/21, EMCON observed VOCs, PAHs, and metals in soil samples from five of the borings. In several of the borings, concentrations appeared to increase with depth. Low levels of VOCs, PAHs, metals, and phenols were detected in the IR-1/21 groundwater samples; the results of the radiation analyses were inconclusive. VOCs were only observed in soil samples from one boring at Site IR-2, but PAHs and metals were found in most of the borings. With the exception of trace levels of naphthalene in one well, no VOCs or PAHs were detected in groundwater samples from Site IR-2 wells; low levels of metals were observed in all five wells. At Site IR-3, VOCs, PAHs, and metals were found in soil samples from all of the borings and in groundwater samples from all of the wells. In addition, floating product was observed in one well (O-3).

Based on the results of EMCON's investigation, Sites IR-1/21, IR-2, and IR-3 were included in the RI/FS program.

3.3 Remedial Investigations

The three phases of RI field work completed at OU I by HLA have consisted of drilling, well installation, trenching, and surface soil sampling. These activities are summarized in Tables 1, 2, and 3, for Sites IR-1/21, IR-2, and IR-3, respectively. Locations are shown on Plates 2, 3, 4, and 5. Early field work and sampling were guided by a regulatory agency-approved work plan (*HLA, 1988c*). Based on field conditions, analytical results, data interpretation, and agency comments, subsequent phases of work evolved from the original work plan. Field investigation dates and sampling information for each phase of field work are summarized below:

- The reconnaissance phase (Phase I), completed in February 1989, consisted of six borings to bedrock at Site IR-1/21, six shallow borings and one boring to bedrock at Site IR-2, and one boring to bedrock at Site IR-3. Additionally, geophysical investigations were performed and 7 test pits excavated to identify the boundaries of the landfill; 23 test pits were excavated at Site IR-2 to evaluate the distribution of sandblast material; a surface scintillation survey of Sites IR-1/21, IR-2, and IR-3 was conducted to evaluate gamma, beta, and x-ray radiation; and a soil gas survey was performed at all three IR sites to evaluate the potential presence of VOCs in the soil and groundwater. Results of the Phase I investigation were presented in the Reconnaissance Activities Report (*HLA, 1990b*). No soil or groundwater samples were collected for chemical analysis.

- The primary phase (Phase II) was subdivided into four subphases. Phase IIA was completed from October 1990 to December 1990, Phase IIB.1 was completed from March 1991 to July 1991, Phase IIB.2 was completed from December 1991 to January 1992, and Phase IIB.3 was completed from April 1992 to May 1992. RI activities included drilling 111 borings, and 42 A-aquifer and 9 B-aquifer wells; excavating 131 test pits; and collecting and analyzing grab groundwater samples from borings, groundwater samples from wells, and soil samples from borings, wells, trenches, and surface soil. The results of the Phase IIA investigation were presented previously in the OU I Primary Phase IIA data submittal (*HLA, 1991c*).

- The contingency phase (Phase III) was completed in August 1992. RI activities included drilling 29 soil borings, installing 4 A-aquifer wells, excavating 5 test pits, and collecting and analyzing grab groundwater samples from borings, groundwater samples from wells, and soil samples from borings, wells, trenches, and surface soil.

The RI field program resulted in the excavation of 166 test pits in 82 trench areas; the drilling of 154 borings, 55 of which were completed as monitoring wells; and the collection of 118 surface soil/intertidal sediment samples. All borings, wells, and test pits from RI activities at Sites IR-1/21, IR-2, and IR-3 are shown on Plates 2, 3, 4, and 5. Boring logs, well construction details, and test pit logs will be included in the Parcel E RI/FS.

3.3.1 Analytical Program

The OU I soil and groundwater analytical programs are summarized in Tables 4 and 5, respectively; the analytical methods used are listed in Appendix B. As part of the primary phase, 1,038 soil samples, 147 groundwater samples, 18 grab groundwater samples from borings, and 133 quality assurance/quality control (QA/QC) samples were submitted for chemical analysis. As part of the contingency phase, 262 soil samples, 120 groundwater samples, 10 grab groundwater samples from borings, and 46 QA/QC samples were submitted for chemical analysis.

Two soil, 57 groundwater, and 10 grab groundwater samples were submitted for radiation analysis because field screening of samples indicated that gamma or beta radiation levels exceeded three standard deviations above the background levels, a criterion presented in the OU I Sampling Plan (*HLA, 1988c*). Nine soil samples were submitted for physical testing; the results will be presented in the parcel RI/FS report.

3.3.2 Quality Assurance/Quality Control

All RI work was performed in substantial accordance with the Quality Assurance Project Plan (QAPjP; *HLA, 1988a*) and site-related work plans (*HLA, 1988c, 1991c*). Deviations from the QAPjP and work plans included the relocation and addition of sampling locations, the subdivision of the primary phase into subphases, and minor modifications to well specifications and the analytical program. The analytical data were reviewed and validated according to the procedures outlined in the QAPjP and in HPA guidance documents for the Contract Laboratory Program (*EPA, 1988a, b*).

3.4 Physical Characteristics

3.4.1 Geology

Five of the six geologic units discussed in Section 2.2 have been identified at OU I. They are, from top to bottom, Artificial Fill (Qaf), Undifferentiated Upper Sand Deposits (Quus), Bay Mud Deposits (Qbm), Undifferentiated Sedimentary Deposits (Qu), and Franciscan Bedrock. The review of aerial photographs and boring and trench logs indicated that Artificial Fill and possibly Undifferentiated Upper Sand Deposits were placed on top of native geologic materials during filling along the bay margin or during landfill operations between 1958 and 1974.

Plates 6 through 11 show geologic cross section interpretations based on boring and well logs obtained during RI activities. These cross sections are generalized to facilitate correlation of major types of fill materials and native geologic sediments. A detailed correlation of various lithology types within artificial fill materials is difficult because of the extreme heterogeneity of these materials. The graphical representation of the lithologic logs on the cross sections is explained on Plate 12. Several borings were not advanced through the entire thickness of the Artificial Fill into native sedimentary deposits (Undifferentiated Upper Sand Deposits or Undifferentiated Sedimentary Deposits) and/or Franciscan Bedrock. In addition, most of the borings advanced into older sedimentary deposits did not fully penetrate the entire thickness of the deposits. As a result, only the thickness of the Artificial Fill has been extensively characterized. The characteristics of the Artificial Fill and the occurrences and character of the four other geologic units encountered beneath the Artificial Fill at OU I are summarized below:

- <u>Artificial Fill (Qaf)</u>

  Found at the ground surface to depths ranging from 5 to 57 feet at all OU I sites. Overlies Bay Mud Deposits in most areas with a few exceptions. At IR-1/21 Artificial Fill overlies Undifferentiated Upper Sand Deposits in the north corner of the landfill where bay mud is absent; Artificial Fill overlies Undifferentiated Sedimentary Deposits at one location in the center of the landfill (Plates 6 and 7). At the southeast end of IR-2, Artificial Fill overlies Undifferentiated Sedimentary Deposits over a wide area (Plate 11). The fill generally consists of clay to boulder-sized bedrock-derived materials. In the center of the landfill the Artificial Fill includes a debris zone characterized by construction and industrial debris and waste and domestic refuse (Plates 2, 6, and 7).

- **Undifferentiated Upper Sand Deposits (Quus)**

  Underlies Artificial Fill at 74 of the 154 borings; the observed thickness ranged from 0.5 to 63 feet. May have been deposited in situ or dredged from the bay for fill. The origin of the upper sand materials cannot be determined from soil samples collected during drilling.

- **Bay Mud Deposits (Qbm)**

  Encountered in all but 17 borings completed to depths greater than 21.5 feet. Bay Mud Deposits underlie both Artificial Fill and Undifferentiated Upper Sand Deposits; the top surface was observed at depths ranging from 2.5 to 57 feet. This top surface is very uneven perhaps in part because of loading pressures from the Artificial Fill and subsequent deformation of the bay mud. In general, bay muds are known to be absent in the northwest corner of the Industrial Landfill and the southeast end of the Bay Fill Area; in other areas bay mud thicknesses ranged from 3.5 to 56 feet.

- **Undifferentiated Sedimentary Deposits (Qu)**

  Encountered in 26 borings. Undifferentiated Sedimentary Deposits underlie the Artificial Fill, Undifferentiated Upper Sand Deposits, and Bay Mud Deposits; the top surface was observed at depths ranging from 24 to 62 feet. Eight borings were advanced through the Undifferentiated Sedimentary Deposits into bedrock; the thickness ranged from 34 to 211 feet.

- **Franciscan Bedrock (sp, KJsk)**

  Encountered in 8 borings; bedrock underlies the Undifferentiated Sedimentary Deposits and was observed at depths ranging from 62 to 269 feet.

3.4.2 Hydrogeology

Both the A- and B-aquifers were encountered at Sites IR-1/21, IR-2, and IR-3.

3.4.2.1 Characteristics of the A-Aquifer

A-aquifer characteristics are summarized as follows:

- Consists of saturated Artificial Fill and, to a lesser extent, Undifferentiated Upper Sand Deposits.

- The top of the A-aquifer is defined by the groundwater table, which is generally 4 to 12 feet bgs, but ranges to as much as 17 feet bgs in the center of the Industrial Landfill. The bottom of the aquifer is defined by the upper surface of the Bay Mud Deposits.

- Saturated thickness ranges from 0 to approximately 42 feet.
- Generally unconfined.

The saturated portions of the A-aquifer are generally unconfined but may be locally confined where fine-grained fill materials overlie coarser-grained fill materials and/or undifferentiated upper sands. The A-aquifer is unsaturated at some boring locations near Triple A Sites 2 and 14 where shallow bay mud materials were encountered above the water table.

In the northwest corner of the Industrial Landfill where the bay mud is absent, the A-aquifer is in direct connection with the B-aquifer.

3.4.2.2 Characteristics of the B-Aquifer

B-aquifer characteristics are summarized as follows:

- Consists of Undifferentiated Sedimentary Deposits.
- The top of the B-aquifer is defined by the bottom surface of the Bay Mud Deposits; its bottom is defined by the upper surface of the Franciscan Complex bedrock.
- Saturated thickness ranges from approximately 34 to 211 feet.
- Generally confined.

3.4.2.3 Groundwater Flow Characteristics

The water-level elevations at the site are interpreted from water levels in the A-aquifer for February and July 1992 and are presented on Plates 13 and 14, respectively. Groundwater flow conditions are summarized as follows:

- The groundwater flow direction in the A- and B-aquifers at Site IR-1/21 is radially outward to the east, southeast, and south from the northwest corner of the landfill. Flow in the A-aquifer generally appears to be inland throughout the remainder of OU I and may be influenced by the sanitary sewer system. Flow in the B-aquifer in the rest of OU I is not known.
- A-aquifer horizontal gradients calculated using February and July 1992 data ranged from approximately 0.002 to 0.017 foot per foot (ft/ft) across

the sites. B-aquifer gradients at IR-1/21 ranged from 0.001 to 0.003 ft/ft during the same time period.

- Tidal influence has been observed in a zone along the margin of the bay ~~ranging in~~ width from 200 to 600 feet. However, no change in the overall flow pattern is produced.

- Vertical gradients between the A- and B-aquifers were observed to be upward at all OU I sites where wells monitoring both aquifers were present.

3.5 Nature and Extent of Contamination

Chemicals in soil and groundwater at OU I derive from both point and nonpoint sources. A point source has been defined by the EPA as "a stationary location or fixed facility from which pollutants are discharged or emitted" (*EPA, 1989b*). Nonpoint sources of both organic and inorganic contamination at HPA may include:

- Anthropogenic sources in the San Francisco Bay area such as former coal gasification plants, oil refineries, coal and wood burning activities, and internal combustion engines, which may have released petroleum hydrocarbons (including polynuclear aromatic hydrocarbons [PAHs]) and lead into the atmosphere or water.

- The fill materials emplaced during the construction of HPA, which included naturally occurring bedrock-derived materials from the upland ridge at HPA and petroleum hydrocarbons and associated constituents (PAHs and metals) that may have leaked from heavy machinery used during filling operations.

- The asphalt-paving operations that may have released petroleum hydrocarbons and associated constituents.

- The application of pesticides in landscaped areas.

Nonpoint sources are not discussed in detail in this report, but will be evaluated in the Parcel E RI/FS.

3.5.1 Chemical Data Evaluation Approach

The soil and groundwater chemical data from the OU I RI were evaluated to identify those contaminants related to point-source releases of contamination. The evaluation of the soil and groundwater data to identify contamination related to point-source releases included the following:

- Reviewed summary statistical information from approximately 1,300 soil samples and 300 groundwater samples to assess frequency of occurrence and maximum and mean concentrations.

- Compared soil and groundwater metal concentrations to previously determined Interim Ambient Levels (IALs) to assess point-source versus nonpoint-source related contamination of metals (*HLA, 1992d,k*). The IALs represent the estimated upper limits of the background (threshold) concentrations of the metals present in the soil and groundwater at HPA. These metals are either (1) naturally occurring (their presence and concentrations are not influenced by humans), (2) naturally occurring but disturbed/mobilized during artificial filling operations, or (3) associated with anthropogenic nonpoint sources. IALs have not yet been approved by the regulatory agencies and are therefore subject to revision.

- Evaluated the consistency of analyte detection in groundwater samples.

- Assessed lateral and vertical trends in the chemical concentrations in soil and groundwater.

- Characterized spatial relationships between areas with high chemical concentrations (hot spots) and areas of known chemical use or release.

- Compared the distribution of chemicals in groundwater to the distribution of chemicals in soil.

The nature and extent of soil and groundwater contamination related to point-source releases are described below. For presentation purposes, soil chemistry data were separated by sample depth and posted on separate plates (i.e., data from samples collected between the ground surface and 2.5 feet bgs [shallow] and samples below 2.5 feet bgs [deep] were presented on separate plates). Presenting the data in this manner facilitates the identification of point-source-related contamination and conforms to the data evaluation and risk assessment formats that will be employed in the Parcel E RI report.

Additionally, the horizontal and vertical extent of chemicals in soil was evaluated to select representative compounds to be posted on plates and discussed in this report. Compounds were detected exhibiting point-source-related contamination in addition to those presented and discussed. However, the compounds selected for discussion are representative of the overall nature and extent of point-source contamination. Based on this evaluation, maximum concentrations in soil of the organic compounds and metals listed below are presented on Plates 15 through 56 in areal and cross section plots:

- Organic compounds: xylenes, ethylbenzene, Aroclor 1260, TPH as diesel, TPH as gasoline, TOG, and carcinogenic PAHs [the sum of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene concentrations]

- Metals: arsenic, copper, lead, and zinc.

These compounds are hereafter referred to as the representative compounds.

It should be noted that chemical concentrations are reported in the text, shown in tables, and shown on plates as provided by the analytical laboratory (i.e., values have not been rounded, except perhaps when converting to different units). However, it is generally assumed when discussing analytical data that the precision of laboratory test methods is only sufficient to allow for three significant figures, even though some laboratories may report more than three significant figures.

3.5.2 Soil Chemistry

This section summarizes the analytical results of soil samples collected during RI activities. Summaries of the valid analytical results for organic (including total PAH compounds) and inorganic data are presented in Tables 6 and 7 for IR-1/21, Tables 8 and 9 for IR-2, and Tables 10 and 11 for IR-3, respectively. Tables 12, 13, and 14 compare soil concentrations of metals at Sites IR-1/21, IR-2, and IR-3, respectively, to IALs for serpentinite fill and present the number of borings from which one or more soil samples had metal concentrations above the IALs. The frequency of detection of metals above IALs at Sites IR-1/21, IR-2, and IR-3 as a function of depth is presented in Table 15. IALs for serpentinite fill were used for comparison of all soil samples for two reasons: (1) IALs calculated for the other lithologic units (nonserpentinite fill, bay mud, Upper Undifferentiated Sand Deposits, and Serpentinite Bedrock) do not vary substantially from those calculated for serpentinite fill, and (2) evaluation of the approximately 1,300 soil samples was simplified.

Organic chemicals including VOCs, SOCs including total carcinogenic and noncarcinogenic PAHs, total oil and grease (TOG), total petroleum hydrocarbons (TPH) as gasoline and diesel, polychlorinated biphenyls (PCBs), and pesticides were detected sporadically in the Artificial Fill. Most of these occurrences of chemicals exhibit nonpoint-source-related characteristics. Exceptions are described in Section 3.5.3.

Most metals were detected at concentrations above the IALs in soil samples at OU I. Antimony, arsenic, copper, hexavalent chromium, lead, mercury, and zinc were detected at levels significantly above IALs and appear to be point-source-related. Although many of the other metals were detected above IALs in some samples, the spatial distribution of these metals is not characteristic of point-source-related contamination (i.e., concentrations decreasing away from a source area).

3.5.3 Nature and Extent of Soil Contamination Related to Point Sources

Various organic and inorganic compounds were detected at Sites IR-1/21, IR-2, and IR-3. As stated in Section 3.5.1, frequency of detection and maximum and mean concentrations were used to assist in identifying point sources of contamination. The suspected primary point sources of soil contamination at Sites IR-1/21, IR-2, and

IR-3 were discussed briefly in Sections 3.1.1, 3.1.2, and 3.1.3, respectively, and are identified below:

- Site IR-1/21
- Triple A Sites 2 and 14, Site IR-2
- Triple A Site 19, Site IR-2
- Triple A Site 18, Site IR-2
- Triple A Site 17, Sites IR-2 and IR-3
- Triple A Site 13, Site IR-2
- Southeast End, Site IR-2

In general the areas correlate with the Triple A Sites previously identified in the IAS. A detailed discussion of chemical distribution and concentrations for each source area follows in Sections 3.5.3.1 through 3.5.3.7.

3.5.3.1 Site IR-1/21

Organic compounds and metals were primarily observed at Site IR-1/21 in both the debris zone and the surrounding Artificial Fill. Plates 15 and 16 present maximum concentrations of xylenes, ethylbenzene, and Aroclor 1260 in shallow and deep soils, respectively, and Plates 17 and 18 present these compounds on Cross Sections A-A' and B-B'. Plates 19 and 20 present maximum concentrations of TPH as diesel, TPH as gasoline, TOG, and carcinogenic PAHs in shallow and deep soils, respectively, and Plates 21 and 22 present these compounds on Cross Sections A-A' and B-B'. Plates 23 and 24 present maximum concentrations of arsenic, copper, lead, and zinc in shallow and deep soils, respectively, and Plates 25 and 26 present these compounds on Cross Sections A-A' and B-B'.

As shown on the maximum concentration plots and cross sections, nearly all of the areas with elevated concentrations are found in the debris zone or Artificial Fill overlying the Bay Mud Deposits. In a few instances, elevated concentrations were observed in the top few feet of bay mud or Upper Undifferentiated Sands underlying the Artificial Fill. No contaminants were observed in the native deposits underlying the bay mud. Maximum concentrations in the debris zone were as follows:

- Xylenes: 519 mg/kg at IR01B011
- Ethylbenzene: 55.7 mg/kg at IR01B011
- Aroclor 1260: 370 mg/kg at IR01MW05A
- TPH as diesel: 11,000 mg/kg at IR01B011
- TPH as gasoline: 9,200 mg/kg at IR01B011
- TOG: 300,000 mg/kg at IR01B006
- Carcinogenic PAHs: 234.6 mg/kg at IR01B021A
- Arsenic: 49 mg/kg at IR01MW16A
- Copper: 175,000 mg/kg at IR01B021A
- Lead: 14,500 mg/kg at IR01MW26B
- Zinc: 15,800 mg/kg at IR01B018G.

Because of the extreme heterogeneity of the debris zone, there is no vertical or lateral consistency or pattern to the distribution of these compounds. However, because high concentrations are common, the entire debris zone is considered a point source.

There were three other areas with elevated concentrations of these compounds. Along the southwest boundary of the site (IR01B056, IR01B060, IR01B061, IR01MW58A, and IR01MW62A), TPH as diesel up to 2,800 mg/kg and carcinogenic PAHs up to 14.7 mg/kg were observed in deep soil between approximately 4 and 18 feet bgs. Maximum concentrations of arsenic, copper, lead, and zinc were 315, 4,190, 4,740, and 116,000 mg/kg, respectively, in this zone. This depth interval corresponds to the lower portion of Artificial Fill in this area.

Along tne east and southeast sides of the landfill (IR01B045, IR01MW42A, IR01MW43A, IR01MW47B, IR01TA07A, IR01TA07B, and IR0TA08B), elevated concentrations of Aroclor 1260, TPH as diesel and gasoline, carcinogenic PAHs, copper, lead, and zinc were observed to a depth of approximately 5 feet. This boundary of IR-1/21 is adjacent to Sites IR-4 and IR-12, where similar contamination has been observed (*HLA, 1993*).

In the western central portion of the site adjacent to the bay (IR01B048A, IR01B049, IR01B050, IR01MW48A, and IR01MW53A), elevated concentrations of copper, lead, and zinc were observed. The highest concentrations generally occurred in soil shallower than 6 feet bgs, but some concentrations above IALs were observed to a depth of 15 feet. Triple A reportedly disposed of sandblast waste in this area. The vertical and lateral extent of sandblast material noted in boring logs appears to correlate closely with the areas identified with elevated concentrations of metals.

3.5.3.2 Triple A Sites 2 and 14, Site IR-2

Organic contaminants and metals were detected in both shallow and deep soils at Triple A Sites 2 and 14, as well as in an area extending approximately 600 feet to the southeast and 200 feet to the north and northeast for some compounds. Plates 27 and 28 present maximum concentrations of xylenes, ethylbenzene, and Aroclor 1260 in shallow and deep soils, respectively, and Plate 29 presents these compounds on Cross Section C-C'. Plates 30 and 31 present maximum concentrations of TPH as diesel, TPH as gasoline, TOG, and carcinogenic PAHs in shallow and deep soils, respectively, and

Plate 32 presents these compounds on Cross Section C-C'. Plates 33 and 34 present maximum concentrations of arsenic, copper, lead, and zinc in shallow and deep soils, respectively, and Plate 35 presents these compounds on Cross Section C-C'.

In general, maximum concentrations of all compounds are higher in deep soil than in shallow. However, the shallow soil contamination is distributed over a wider area than that in deep soil. Elevated concentrations extend to a depth of 6 to 12 feet, depending on the depth to bay mud, which is generally quite shallow (i.e., 6 to 7 feet bgs) in some areas; some metals above IALs were observed as deep as 20 feet bgs. Typically, no contaminants are observed below the top few feet of bay mud. Maximum concentrations of the representative compounds (as discussed in Section 3.5.1) in deep soil were as follows:

- Xylenes: 55 mg/kg at IR02B250
- Ethylbenzene: 5.7 mg/kg at IR02B361
- Aroclor 1260: 487 mg/kg at IR02MW127B1
- TPH as diesel: 15,000 mg/kg at IR02B249
- TPH as gasoline: 6,700 mg/kg at IR02B249
- TOG: 53,000 mg/kg at IR02TA19C
- Carcinogenic PAHs: 95.5 mg/kg at IR02TA19C
- Arsenic: 53 mg/kg at IR02MW141A
- Copper: 197,619 mg/kg at IR02MW127B
- Lead: 26,300 mg/kg at IR02B123
- Zinc: 61,300 mg/kg at IR02B123.

The Aroclor 1260 and carcinogenic PAHs were observed in soil above 4 feet bgs near the north boundary of Site IR-2 (IR02B249, IR01MW44A, and IR02TA10A), and appear to be continuous with similar contaminants observed in the southeast corner of Site IR-1/21.

Hexavalent chromium was also detected at seven locations (IR02B125, IR02B134, IR02B143, IR02B151, IR02B253E, IR02MW127B, and IR02TA17B) in this area between 2.5 and 11 feet bgs at concentrations ranging from 0.2 to 1.1 mg/kg.

3.5.3.3 <u>Triple A Site 19, Site IR-2</u>

Organic contaminants are limited to a relatively small area both laterally and vertically at Triple A Site 19. Plates 27 and 28 present maximum concentrations of xylenes, ethylbenzene, and Aroclor 1260 in shallow and deep soils, respectively; Plates 30 and 31 present maximum concentrations of TPH as diesel, TPH as gasoline, TOG, and carcinogenic PAHs in shallow and deep soils, respectively.

In shallow soil, TPH as diesel is the primary chemical detected at a maximum concentration of 12,000 mg/kg at Test Pit IR02TA57A. In deep soil, xylenes, TPH as diesel and gas, TOG, and carcinogenic PAHs were commonly detected. No contaminants were detected below 7 feet bgs; all organic contamination was restricted to the Artificial Fill. Maximum concentrations of detected compounds in deep soil are summarized below:

- Xylenes: 9.5 mg/kg at IR02B108A
- TPH as diesel: 17,000 mg/kg at IR02TA57A
- TPH as gasoline: 1,800 mg/kg at IR02B108A
- TOG: 77,000 mg/kg at IR02B108A
- Carcinogenic PAHs: 3.9 mg/kg at IR02TA56B.

Plates 33 and 34 present maximum arsenic, copper, lead, and zinc concentrations in shallow and deep soils at Triple A Site 19, respectively. In shallow soil, only lead is observed above the IAL; the maximum concentration is 140 mg/kg at Boring IR02B111. Concentrations of all four metals are above IALs in deep soil between 6 and 11 feet bgs, especially at IR02B108A, IR02TA56B, IR02TA56A, and IR02TA56B. Maximum concentrations of arsenic, copper, lead, and zinc in the deep soils are 43, 1,042, 1,242, and 1,304 mg/kg, respectively.

In addition, approximately 200 feet southeast of Triple A Site 19 near the northeast corner of Building 600, elevated concentrations of copper, lead, and zinc were detected in a lower zone of soil between 15.5 and 20 feet bgs. Maximum concentrations of copper, lead, and zinc at this location were 800, 1,590, and 3,280 mg/kg, respectively. This area does not correspond to a previously identified potential source area. However, correlation of boring logs in this area indicates that the elevated concentrations are in a zone of fill that appears to be dredge materials.

3.5.3.4 Triple A Site 18, Site IR-2

At Triple A Site 18, organic compounds were observed at the east and west ends of the site (Plates 27, 28, 30, and 31). At the east end of the site (IR02B100, IR02TA30B, and IR02TA31B), Aroclor 1260, TPH as diesel, TOG, and carcinogenic PAHs were detected from the ground surface to a depth of about 6 feet. At the west end of the site, TPH as diesel and carcinogenic PAHs were observed in the sample from Test Pit IR02TA25B. Additionally, in debris piles behind the backstop of the pistol range, just west of the site (IR02SS319, IR02SS320, and IR02SS321), Aroclor 1260 and carcinogenic PAHs were detected in two surface soil grab samples. No deeper samples have been collected from these debris piles. Maximum concentrations of organic compounds detected at all locations within Triple A Site 18 are as follows:

- Aroclor 1260: 45 mg/kg at IR02SS320

- TPH as diesel: 7,900 mg/kg at IR02TA31B
- TOG: 54,000 mg/kg at IR02B290
- Carcinogenic PAHs: 21.97 mg/kg at IR02SS320.

Across Triple A Site 18, metals exceeding IALs are generally limited to shallow soil (Plates 33 and 34). Maximum concentrations of arsenic, copper, and lead in this area were 56, 1,590, and 1,440 mg/kg, respectively. Copper above the IAL was found below 2.5 feet only in a small area near Test Pit IR02TA29A and Boring IR02B289 at a maximum concentration of 2,150 mg/kg. Elevated concentrations of lead were observed across Triple A Site 18 in deep soil, but in general, concentrations were just above the IAL. The highest concentration of lead in deep soil was at Test Pit IR02TA29A at 216 mg/kg.

In the area of the pistol range, backstop, and the debris piles, surface soil samples indicate that arsenic, copper, lead, and zinc are present in the shallow soil at concentrations above the IALs.

3.5.3.5 Triple A Site 17, Sites IR-2 and IR-3

Organic compounds and metals were detected at Triple A Site 17 in shallow and deep soils. Plates 36 and 37 present maximum concentrations of xylenes, ethylbenzene, and Aroclor 1260 in shallow and deep soils, respectively, and Plates 38 and 39 present these compounds on Cross Sections D-D' and E-E'. Plates 40 and 41 present maximum concentrations of TPH as diesel, TPH as gasoline, TOG, and carcinogenic PAHs in shallow and deep soils, respectively, and Plates 42 and 43 present these compounds on Cross Sections D-D' and E-E'. Maximum concentrations of arsenic, copper, lead, and zinc are presented for shallow and deep soils on Plates 44 and 45, respectively, and Plates 46 and 47 present these compounds on Cross Sections D-D' and E-E'.

Organics contamination at Triple A Site 17 generally increases with depth, while metals contamination is consistently high in both the shallow and deep soils. TPH as diesel, carcinogenic PAHs, and Aroclor 1260, were found in shallow soil at maximum concentrations of 320, 92.8, and 12 mg/kg, respectively.

In deep soil, concentrations of organic compounds were significantly higher (i.e., as much as one to two orders of magnitude) than in shallow soil. The difference may be the result of free phase product floating on the groundwater and residual product present in the soil between 6 and 25 feet bgs (Plate 9). Maximum concentrations of organic compounds detected in deep soil are:

- Xylenes: 32 mg/kg at IR03TA47C
- Aroclor 1260: 10 mg/kg at IR03TA53F
- TPH as diesel: 8,900 mg/kg at IR02MW146A
- TPH as gasoline 1,000 mg/kg at IR02MW173A
- TOG: 42,000 mg/kg at IR03MW226A
- Carcinogenic PAHs: 92.8 mg/kg at IR03SS368.

Metals in shallow soil are widely distributed across nearly all of Triple A Site 17. The maximum concentration and range of concentrations observed in shallow soil for these four metals are summarized below:

- Arsenic: maximum 641 mg/kg; range 15 to 30 mg/kg
- Copper: maximum 10,500 mg/kg; range 1,000 to 4,000 mg/kg
- Lead: maximum 1,075 mg/kg; range 100 to 400 mg/kg
- Zinc: maximum 2,310 mg/kg; range 120 to 1,000 mg/kg.

The lateral distribution of elevated metals concentrations in deep soil is somewhat narrower, extending just beyond the Site IR-3 boundaries and to K Street. The maximum concentration and range of concentrations observed in deep soil for these four metals are summarized below:

- Arsenic: maximum 166 mg/kg; range 15 to 50 mg/kg
- Copper: maximum 39,300 mg/kg; range 110 to 3,000 mg/kg
- Lead: maximum 2,030 mg/kg; range 100 to 500 mg/kg
- Zinc: maximum 20,400 mg/kg; range 150 to 2,000 mg/kg.

The vertical distribution of arsenic, copper, lead, and zinc across the site is shown on Cross Sections D-D′ and E-E′ (Plates 46 and 47). These cross sections indicate that elevated metals concentrations are restricted to the Artificial Fill overlying the bay mud.

No contaminants were observed below the top few feet of the Bay Mud Deposits underlying the Artificial Fill.

3.5.3.6 Triple A Site 13, Site IR-2

Soil contamination at Triple A Site 13 is limited to a fairly small area and only a few compounds. Plates 48 and 49 present maximum concentrations of xylenes, ethylbenzene, and Aroclor 1260 in shallow and deep soils, respectively, and Plate 50 presents these compounds on Cross Section F-F'. Plates 51 and 52 present maximum concentrations of TPH as diesel, TPH as gasoline, TOG, and carcinogenic PAHs in shallow and deep soils, respectively, and Plate 53 presents these compounds on Cross Section F-F'.

Within the area adjacent to Tank S-505, TPH as diesel and TOG were detected in shallow soil at one location, IR02B356, and in deep soil up to 6 feet bgs at two locations, IR02B355 and IR02B356. The maximum TPH as diesel and TOG concentrations were 6,400 and 21,000 mg/kg, respectively. TPH as gasoline was also detected in one location, IR02B355, at 6 feet bgs at a concentration of 2,100 mg/kg.

Most observed metals concentrations in this area were generally below IALs. Lead was observed at concentrations slightly above the IAL in the shallow soil at a maximum concentration of 36 mg/kg. Copper, lead, and zinc concentrations in deep soil exceeded IALs in this area, primarily at about 6 feet bgs with maximum concentrations of 210, 86.7, and 267 mg/kg, respectively.

In the area of the site adjacent to the bay, Aroclor 1260 and carcinogenic PAHs were detected. The maximum Aroclor 1260 concentration observed was 1.0 mg/kg at IR02B359 at a depth of 8.75 feet. The maximum carcinogenic PAHs concentration was 3.1 mg/kg at IR02B360 at a depth of 21.25 feet. Metals in excess of IALs were widespread, with maximum shallow soil concentrations of copper, lead, and zinc of 548, 261, and 984 mg/kg, respectively. Hexavalent chromium was also detected in shallow soil at three locations (IR02B207, IR02B360, and IR02MW209A) at concentrations ranging from 0.12 to 0.3 mg/kg. In deep soil, arsenic, copper, lead, and zinc maximum concentrations were 29, 267, 1,130, and 939 mg/kg, respectively, and were observed primarily above 9 feet bgs. No hexavalent chromium was detected in deep soil samples.

3.5.3.7 <u>Southeast End, Site IR-2</u>

Various organic compounds were detected near the southeast end of Site IR-2 (Plates 48 through 56). This area has not previously been identified as a point-source related area at OU I. Present evidence of contamination and observations of subsurface conditions during drilling and trenching appear to indicate that this area may correspond to the burn area previously believed to be about 400 feet to the north, or it may be that this land area of Site IR-2 was created by pushing the remains of the burned debris into the bay.

In shallow soil, few organic compounds were detected. Only carcinogenic PAHs were found across most of this area; concentrations generally ranged from 1.0 to 3.5 mg/kg. Metals were also fairly widespread in shallow soil. The maximum concentration and typical range of concentrations observed in shallow soil are summarized below:

- Arsenic: 99.5 mg/kg at IR02B184 (only one detected value)
- Copper: 1,653 mg/kg; typical range 100 to 180 mg/kg
- Lead: 1,336 mg/kg; typical range 60 to 160 mg/kg
- Zinc: 1,660 mg/kg; typical range 120 to 320 mg/kg.

Contamination is somewhat more prevalent in deep soil than in shallow. Carcinogenic PAHs are widespread with, a maximum concentration of 14.3 mg/kg. TPH as diesel is also present in several locations with, a maximum concentration of 1,700 mg/kg. Metals in deep soil generally appear to be limited to a smaller area than in shallow soil. The maximum concentration and typical range of metals concentrations observed in deep soil are summarized below:

- Copper: 2,090 mg/kg; typical range 160 to 500 mg/kg
- Lead: 1,090 mg/kg; typical range 200 to 400 mg/kg
- Zinc: 4,600 mg/kg; typical range 160 to 1,500 mg/kg.

In this area of IR-2, organic compounds are typically found in soil shallower than 8 feet bgs, and metals in excess of IALs are typically found in soil above 16 feet bgs (Plates 50, 53, and 56). Contamination is, in general, limited to the Artificial Fill, the Undifferentiated Upper Sands (which appear to be dredge spoils in this area), and the upper few feet of the bay mud.

3.5.4 Groundwater Chemistry

This section summarizes the analytical results for groundwater samples collected during RI activities. Tables 16 and 17 (Site IR-1/21), 18 and 19 (Site IR-2), and 20 and 21 (Site IR-3) summarize the valid organic and inorganic chemical data, respectively. Tables 22 and 23 are statistical summaries of organic analytes exceeding federal and state MCLs and inorganic analytes exceeding federal and state MCLs or IALs, respectively, in groundwater at Site IR-1/21. Similar data are presented in Tables 24 (organics) and 25 (inorganics) for Site IR-2, and Tables 26 (organics) and 27 (inorganics) for Site IR-3. Compounds that were detected in only one round are not discussed below.

VOCs, SOCs and one PCB compound were detected above MCLs. Other compounds detected which have no MCLs include TPH compounds, pesticides, and other SOCs. Consistently detected organic compounds are summarized below:

- Site IR-1/21
  - Benzene and 1,4-dichlorobenzene were detected in 10 wells
  - Aroclor 1260 was detected in 6 wells.
- Site IR-2
  - Aroclor 1260 was detected in 3 wells.
- Site IR-3
  - Benzene was detected in 3 wells
  - Aroclor 1260 was detected in 4 wells
  - Chlorobenzene and 1,4-dichlorobenzene were detected in 1 well.

Aluminum, arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, and silver were detected at the OU I sites above both applicable IALs and MCLs (Tables 23, 25, and 27).

3.5.5 Nature and Extent of Groundwater Contamination Related to Point Sources

Organic compounds with concentrations above MCLs, and metals concentrations above IALs and MCLs detected in several sampling rounds may be point-source related. Table 28 summarizes compounds detected in each well above MCLs and/or IALs, the continuity of detections over time, and whether each compound is used for data interpretation purposes. Benzene and Aroclor 1260 were the most frequently occurring organic compounds and were detected at the highest concentrations of the detected organic analytes. Maximum concentrations in groundwater of benzene and Aroclor 1260 are presented on Plates 57 through 60 for Sites IR-1/21, IR-2, and IR-3.

A large number of metals were detected above MCLs or IALs in many wells; however, most of these detections occurred during only one sampling round. Concentrations of metals in approximately one-half of the samples collected during the July 1992 sampling event were anomalously high when compared with concentrations observed during previous and subsequent sampling events. After thorough review of all field notes and forms, laboratory reports and disks, and the database, it was decided that the filters used during filtering of the samples collected for metals analysis were defective or of substandard quality. Additionally, eight of the wells sampled during the OU I sampling round in August 1992 had similarly elevated levels of metals. The affected July and August 1992 results are considered anomalous and not discussed further in this report. The rationale for eliminating each anomalous detected value in excess of the MCL from further analysis is shown in Table 28. Metals in groundwater as a result of point-source-related contamination are not widespread; therefore, no metals data are presented on plates.

Areas with groundwater point-source-related contamination have been identified at three areas of the OU I sites: (1) Site IR-1/21, (2) Triple A Sites 2/14 and the northwestern end of Site IR-2, and (3) Triple A Site 17 at Sites IR-2 and IR-3. These areas generally correspond to those with similar contamination observed in soil. A detailed discussion of chemical distribution and concentrations for each point source follows in Sections 3.5.5.1 through 3.5.5.3.

3.5.5.1 Site IR-1/21

Organic compounds and metals in groundwater were observed at Site IR-1/21 in both the debris zone and the surrounding Artificial Fill. Plate 57 presents the maximum concentrations of benzene and Aroclor 1260 in groundwater. Maximum concentrations of compounds above MCLs and/or IALs and the number of wells with these compounds are summarized below:

- Benzene: Detected in 10 wells at concentrations ranging from 2 to 44 $\mu g/l$
- Aroclor 1260: Detected in 5 wells at concentrations ranging from 16 to 54 $\mu g/l$
- 1,4-Dichlorobenzene: Detected in 4 wells at concentrations ranging from 7 to 16 $\mu g/l$
- Barium: Detected in Well IR01MW62A at a concentration of 7,480 $\mu g/l$
- Chromium: Detected in Well IR01MW02B at a concentration of 80 $\mu g/l$
- Lead: Detected in Well IR01MW42A at a concentration of 100 $\mu g/l$.

In general, contaminants in groundwater are limited to the A-aquifer. The exception is in the north corner of the landfill where the bay mud separating the A- and B-aquifers is absent. As listed above, chromium was found in Well IR01MW02B above

MCLs and IALs. Several organic compounds were also observed in this well, but at concentrations well below MCLs. In the other B-aquifer wells, organic compounds were either below detection limits or not detected consistently, and metals were below the IALs and MCLs.

Additionally, benzene was detected at concentrations ranging from 1 to 6 $\mu g/l$ in three wells along the southwest boundary of the site (IR01MW58A, IR01MW62A, and IR01MW63A). No benzene was observed in soil samples from these wells or elsewhere in this area. Because the hydraulic gradient in this area is generally south or east toward the bay, this may indicate that the benzene in these wells is migrating onto the facility from offsite sources west or north of this area. Aroclor 1260 was detected in one well, IR01MWI-9, southwest of the debris zone at a concentration of 4.5 $\mu g/l$. No Aroclor 1260 or other PCBs were observed in soil samples from this area.

3.5.5.2 Triple A Sites 2 and 14, Site IR-2

Several organic compounds and metals were observed in groundwater at Triple A Sites 2 and 14 above MCLs and/or IALs, but in general, there is little groundwater contamination in this area. Plate 58 presents the maximum concentrations of benzene and Aroclor 1260 in groundwater. Maximum concentrations of compounds above MCLs and/or IALs and the number of wells with these compounds are summarized below:

- Aroclor 1260: Detected in Wells IR02MW126A and IR02MW141A at concentrations of 4.1 and 5.1 $\mu g/l$, respectively

- Pentachlorophenol: Detected in Well IR02MWB-3 at a concentration of 6 $\mu g/l$

- Barium: Detected in Wells IR02MW114A3 and IR02MW126A at concentrations of 1,120 and 1,020 $\mu g/l$, respectively.

Aroclor 1260 was widespread in shallow and deep soils at Triple A Sites 2 and 14, as described above in Section 3.5.3.2. Pentachlorophenol was not detected in soil within Triple A Sites 2 and 14.

3.5.5.3 Triple A Site 17, Sites IR-2 and IR-3

Organic compounds and metals were detected in several wells in the vicinity of Triple A Site 17. Plate 59 presents maximum benzene and Aroclor 1260 concentrations in groundwater. Maximum concentrations of compounds above MCLs and/or IALs and the number of wells with these compounds are summarized below:

- Benzene: Detected in five wells at concentrations ranging from 3 to 13 μg/l
- Aroclor 1260: Detected in four wells at concentrations ranging from 0.7 to 290 μg/l
- Chlorobenzene: Detected in Wells IR03MW225A and IR03MWO-1 at concentrations of 150 and 66 μg/l, respectively
- 1,4-Dichlorobenzene: Detected in Wells IR03MW225A and IR03MWO-1 at concentrations of 17 and 57 μg/l, respectively
- 1,2-Dichloroethane: Detected in Well IR03MW225A at a concentration of 4 μg/l
- Arsenic: Detected in Wells IR02MW173A and IR03MWO-1 at concentrations of 54.6 and 1,180 μg/l, respectively
- Barium: Detected in four wells at concentrations ranging from 4,250 to 19,400 μg/l
- Selenium: Detected in Well IR03MW225A at a concentration of 32 μg/l.

Benzene and Aroclor 1260 contamination in shallow and deep soil were reported as discussed in Section 3.5.3.5. The other organic compounds observed in the groundwater are typically also observed in the soil. In addition, contamination of the groundwater may be a result of the presence of floating product.

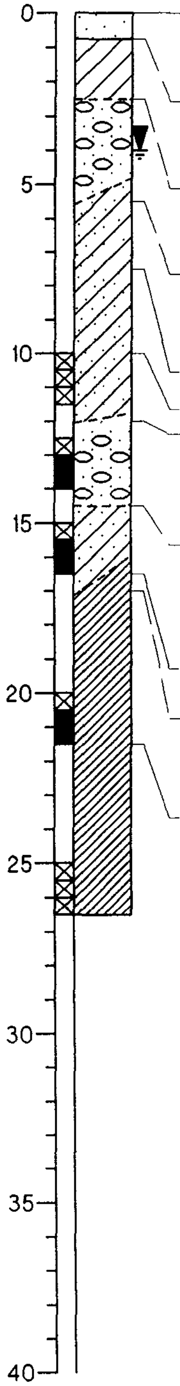
Floating product has been observed in as many as seven monitoring wells in the vicinity of the Oil Reclamation Ponds (Plate 59). Because of tidal fluctuations in the bay, the oil thickness measured in the wells varies temporally by as much as 1.6 feet. The maximum thickness observed has been in Wells IR02MW146A, IR02MW173A, IR03MWO-2, and IR03MWO-3 and ranged between 4.2 and 4.6 feet. Monitoring Wells IR03MW218A1, IR03MW225A, and IR03MWO-1 have also had measurable amounts of product, ranging from a trace to 2.1 feet.

Tables 29 and 30 summarize the valid organic and inorganic chemical data, respectively, for samples of the floating product obtained from Wells IR02MW146A, IR02MW173A, IR03MWO-2, and IR03MWO-3. VOCs, PAHs, PCBs, TPH as diesel, and metals were all detected at elevated concentrations.

B2 - SOIL BORING LOGS FOR IR-03 VICINITY

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR02B098



Blows/6 in.	OVA (ppm)	Sample No.
	0	
	0	
3		
4	20	
4		
9		
19		9150H013
24		
3		
4		9150H014
4		
2		
2	60	9150G652
2		
2		
2	70	
3		

Materials Description

VERY DARK GRAYISH BROWN WELL-GRADED SAND (SW) 2.5Y3/2, loose, moist, fine- to coarse-grained sand, some carbon material, fill

VERY DARK GRAYISH BROWN GRAVELLY LEAN CLAY (CL) 2.5Y3/2, stiff, moist, 60% clay, 30% well-graded gravel, 10% fine-grained sand, fill

DARK GRAY CLAYEY GRAVEL WITH SAND (GC) 5Y4/1, medium dense to dense, wet, 50-60% well-graded gravel, 20-30% fine- to medium-grained sand, 20% lean clay, fill

VERY DARK GRAY CLAYEY SAND (SC) 5Y3/1, loose to medium dense, wet, 70% fine-grained sand, 30% lean clay, fill

Hard, unable to sample at 7.5 ft.

Wood debris, moderate sheen at 10 ft.

BLACK CLAYEY GRAVEL WITH SAND (GC) 5Y2.5/1, medium dense, wet, 50-60% well-graded gravel, 20% fine-grained sand, 20% lean clay, trace to few wood debris, very strong product sheen, fill

BLACK POORLY GRADED SAND WITH CLAY (SP-SC) 5Y2.5/1, loose, wet, 90-95% fine-grained sand, 5-10% clay, trace shell fragments, moderate sheen, Undifferentiated Upper Sand Deposits

Color change to olive gray (5Y4/2), no observed sheen at 16.5 ft. Driller indicates change at approximately 17 ft.

DARK GREENISH GRAY FAT CLAY (CH) 5BG4/1, soft, moist, 80-85% clay, 10-15% silt, trace shell fragments, Bay Mud Deposits

Trace fibrous wood material at 21.5 ft.

Trace fibrous wood material at 25 ft.

Bottom of boring at 26.5 feet. Boring backfilled with bentonite cement grout (12/13/91). Grab water sample 9150G651 collected.

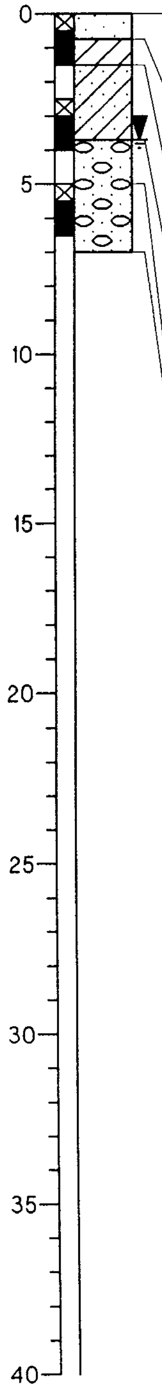
Project Number		Date Drilled	12/12/1991
Project Name	Naval Station, Treasure Island	GS Elevation	6.33
Project Task	Hunters Point Annex	Water Level	4.0 ft.
Project Location	San Francisco, California	Total Depth Of Hole	26.5 ft.
Equipment	CME 55 (HSA) 8 in. diam.		

Figure

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR02B098D

Blows/6 in.	OVA (ppm)	Sample No.
20 23	0	9150H010
3 3 6		9150H011
2 12 30		9150H012



Materials Description

VERY DARK GRAYISH BROWN WELL-GRADED SAND (SW) 2.5Y3/2, loose, moist, mostly fine- to coarse-grained sand, some carbon material, fill

VERY DARK GRAYISH BROWN GRAVELLY LEAN CLAY (CL) 2.5Y3/2, stiff, moist to dry, 50-60% clay, 30-40% well-graded gravel, trace to 10% fine-grained sand, fill

OLIVE BROWN POORLY GRADED SAND WITH CLAY (SP-SC) 2.5Y4/3, medium dense, mostly shell fragments, 40% fine-grained sand, 10% lean clay, fill

VERY DARK GRAY CLAYEY GRAVEL WITH SAND (GC) loose to medium dense, wet, 50-70% well-graded serpentinite and chert gravel, 20% lean clay, 10-30% fine-grained sand, fill

Very strong sheen on gravel at 5 ft.

Auger refusal at 7 feet. Boring backfilled with bentonite cement grout (12/13/91).

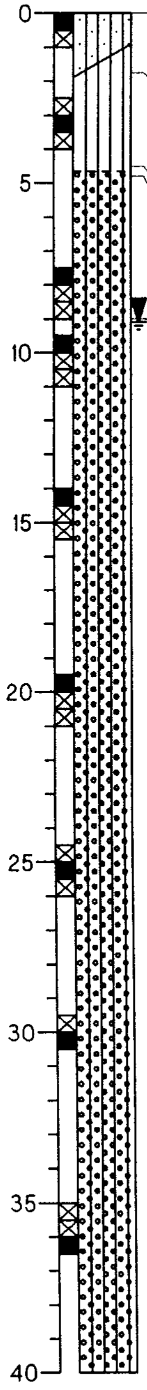
Project Number	Date Drilled 12/12/1991
Project Name Naval Station, Treasure Island	GS Elevation 6.33
Project Task Hunters Point Annex	Water Level 3.7 ft.
Project Location San Francisco, California	Total Depth Of Hole 7.0 ft.
Equipment CME 55 (HSA) 8 in. diam.	Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR02B166

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)
50			0
12 14 40	7	9045N086	
			5
7 5 4	1	9045N087	
12 10 7		9045N088	10
4 5 7	20	9045N089	15
15 12 11	0	9045N090	20
22 35 36	10	9045N091	25
46 50	2	9045N092	30
10 15 12	1	9045N093	35
			40



Materials Description

DARK BROWN WELL-GRADED SAND WITH SILT (SW-SM) 7.5YR3/2, very dense, dry, 75% sand, 15% fine gravel, 10% silt, fill

GRAYISH BROWN SILT WITH SAND (ML) 2.5Y5/2, very stiff, moist, 80% silt, 15% very fine- to medium-grained sand, 5% fine gravel, fill

No sample recovery from 4.5 to 6 ft.

OLIVE POORLY GRADED GRAVEL WITH SILT (GP-GM) 5Y4/3, loose, moist, 75% fine subangular greenstone gravel, 10% coarse-grained sand, 5% silt

Wet at 9 ft. with sheen

Oil droplets

Yellowish brown (10YR5/6) mottling

No sheen at 36 ft.

Project Number ______

Project Name Naval Station, Treasure Island

Project Task Hunters Point Annex

Project Location San Francisco, California

Equipment CME 55 (HSA) 8 in. diam.

Date Drilled 11/06/1990

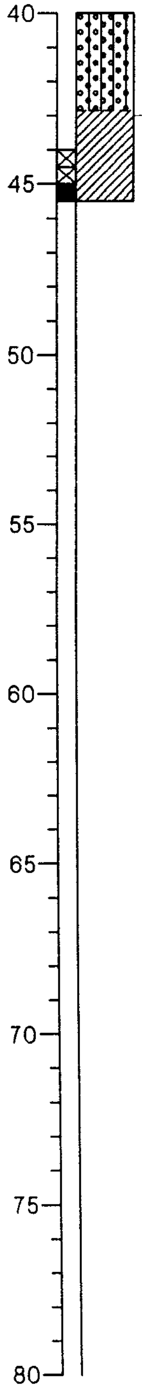
GS Elevation 9.17

Water Level 9.10 ft.

Total Depth Of Hole 45.5 ft.

Figure

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)	Materials Description
16				DARK GRAY FAT CLAY WITH SAND (CH) 5Y4/1, soft, wet, 75% clay, 20% fine-grained sand, 5% fine gravel
35		9045N094	45	
40				Bottom of boring at 45.5 feet. Boring backfilled with bentonite cement grout (11/7/90)



Project Number
Project Name Naval Station, Treasure Island
Project Task Hunters Point Annex
Project Location San Francisco, California
Equipment CME 55 (HSA) 8 in. diam.
Date Drilled 11/06/1990
GS Elevation 9.17
Water Level 9.10 ft.
Total Depth Of Hole 45.5 ft.
Figure

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR02B166A

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)
22, 28, 35	0	9045N073	
22, 28	0	9045N074	5
12, 12, 21	0	9045N075	
8, 50			
10, 7, 8	0	9045N076	10
9, 10, 8, 11, 14, 19	8	9045N077	15
18, 21, 24			20
22, 18, 36	0	9045N078	25
22, 21, 30	30	9045N079	30
			35
			40

Depth (ft)	Materials Description
0	GREENISH GRAY GRAVELLY SILT (ML) 5GY6/1, stiff, dry, 50% silt, 30% fine angular serpentinite gravel, 20% fine- to medium-grained sand
4.5	Fine to coarse gravel at 4.5 ft.
~8	No sample recovery
10	Wet at 10 ft.
~11.5	DARK GREENISH GRAY WELL-GRADED SAND (SW) 5GY4/1, medium dense, wet, 95% fine- to very coarse-grained sand, 5% silt, oily sheen
20	No sample recovered at 20 ft.
25	DARK GREENISH GRAY GRAVEL WITH SAND (GP) 5G4/1, dense, wet, 80% coarse angular gravel, 20% medium-grained sand
30	DARK GREENISH GRAY SILT WITH GRAVEL (ML) 5G4/1, dense, wet, 75% silt, 20% fine subangular gravel, 5% fine- to medium-grained sand
32	Bottom of boring at 32 feet. Boring backfilled with bentonite cement grout (11/6/90)

Project Number ____
Project Name: Naval Station, Treasure Island
Project Task: Hunters Point Annex
Project Location: San Francisco, California
Equipment: CME 55 (HSA) 8 in. diam.

Date Drilled: 11/05/1990
GS Elevation: ~9.17
Water Level: 10.00 ft.
Total Depth Of Hole: 32 ft.

Figure

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR02B170

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)	Materials Description
22 40	0	9044G400	0	STRONG BROWN SILTY SAND WITH GRAVEL (SM) 7.5YR4/6, dense, dry, 45-55% well-graded sand, 20-25% silt, 20-25% fine angular gravel, fill
14 18 12	0	9044G401		DARK REDDISH BROWN SILTY GRAVEL (GM) 5YR3/3, medium dense, moist, 40-45% fine to coarse gravel, 20-30% silt, 10% sand, trace clay, fill
7 7 14	4	9044G402	5	BROWN GRAVELLY LEAN CLAY (CL) 7.5YR4/4, medium stiff, moist, 40-45% clay, 20-25% fine gravel to small cobble size material, 10% sand, 10% silt, trace wood, fill
10 8 12				No sample recovered at 7 ft.
7 7 11		9044G403	10	OLIVE GRAY WELL-GRADED GRAVEL WITH SILT (GW-GM) medium dense, wet, 75-80% fine to coarse angular gravel, 10% silt, 5-10% sand, fill
14 12 11	1	9044G404	15	DARK GREENISH GRAY WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM), 5GY4/1, medium dense, wet, 70-75% fine- to coarse sand, 15% fine angular gravel, 10% silt, fill Heaving sands at 18 ft.
18 25 29	10	9044G405	20	
8 10 9	0	9044G406	25	GREENISH GRAY WELL-GRADED GRAVEL WITH SILT AND SAND (GW-GM), 5G5/1, medium dense, wet, 65-75% fine angular mostly greenstone gravel, 15% sand, 10% silt, fill
15 23 18		9044G407	30	DARK GREENISH GRAY CLAYEY SAND WITH GRAVEL (SC) 5GY4/1, medium dense, moist to wet, 40-45% well-graded sand, 20-25% clay, 20-25% fine to coarse angular gravel, 10% silt, fill
6 20 14	5	9044G408	35	
2 2			40	DARK GREENISH GRAY FAT CLAY (CH) 5GY4/1, soft, moist, 75-80% clay, 10-15% silt, 5-10% shell fragments, bay mud deposits

Project Number		Date Drilled	11/02/1990
Project Name	Naval Station, Treasure Island	GS Elevation	7.68
Project Task	Hunters Point Annex	Water Level	8.00 ft.
Project Location	San Francisco, California	Total Depth Of Hole	46 ft.
Equipment	CME 55 (HSA) 8 in. diam.	Figure	

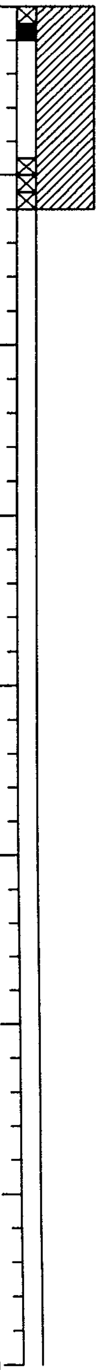
PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR02B170

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)	Materials Description
2	5	9044G409	40	
2			45	Increasing shell fragments to 10-15% at 44.5 ft.
2				
3				Bottom of boring at 46 feet. Boring backfilled with bentonite cement grout (11/5/90)
			50	
			55	
			60	
			65	
			70	
			75	
			80	

Samples Symbols



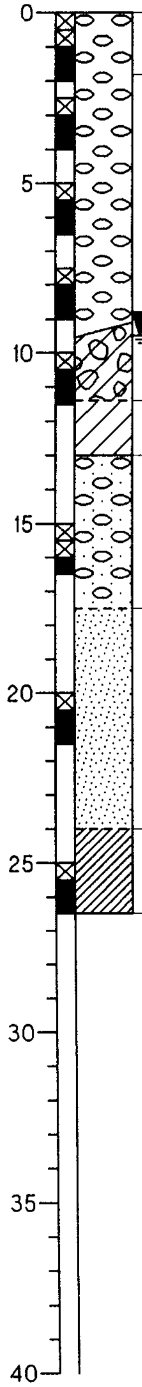
Project Number	Date Drilled 11/02/1990
Project Name Naval Station, Treasure Island	GS Elevation 7.68
Project Task Hunters Point Annex	Water Level 8.00 ft.
Project Location San Francisco, California	Total Depth Of Hole 46 ft.
Equipment CME 55 (HSA) 8 in. diam.	

Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR02B293



Blows/6 in.	OVA (ppm)	Sample No.
23, 20, 21	0	9226N023
8, 17, 17	0	9226N024
14, 13, 14	0	9226N025
6, 6, 6	0	9226N026
4, 6, 6	0	9226N027
11, 16, 9	0	9226N028
1, 1, 1	0	9226N029
1, 1, 3	30	9226N030

Materials Description

GRAY SILTY GRAVEL WITH SAND (GM) 10YR5/1, soft, dry, 50% gravel, 25% silt, 25% fine-grained sand, fill

Color change to very dark grayish brown (10YR3/2), dense, moist at 1.8 ft.

Color change to dark reddish gray (5YR4/2) at 5 ft. with a 2 inch thick sand lens at 5.75 ft.

VERY DARK GRAY GRAVEL WITH CLAY AND SAND (GW-GC) 5YR3/1, loose, wet, 50% gravel, 40% sand, 10% lean clay, trace wood fragments, fill

VERY DARK GRAY SANDY LEAN CLAY WITH GRAVEL (CL) 5YR3/1, soft, wet, fill

DARK GRAY CLAYEY GRAVEL WITH SAND (GC) 5YR4/1, loose, wet, 60% gravel, 20% clay, 20% fine-grained sand, fill

VERY DARK GRAYISH BROWN POORLY GRADED SAND (SP) 10YR3/2, loose, wet, 90% fine-grained sand, 10% shell fragments, Undifferentiated Upper Sand Deposits

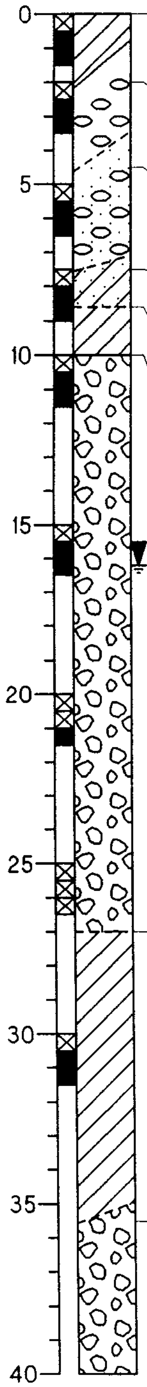
DARK GREENISH GRAY FAT CLAY (CH) 5GY4/1, medium stiff, moist, 100% clay, trace shell fragments, Bay Mud Deposits

Bottom of boring at 26.5 feet. Boring backfilled with bentonite cement grout (6/22/92).

Project Number	
Project Name	Naval Station, Treasure Island
Project Task	Hunters Point Annex
Project Location	San Francisco, California
Equipment	DRILL SYSTEMS 1000 (ACH) 10 in. diam.
Date Drilled	06/22/1992
GS Elevation	6.87
Water Level	9.5 ft.
Total Depth Of Hole	26.5 ft.
Figure	

Blows/6 in.	OVA (ppm)	Sample No.
23 14 10	0	9223H206
20 12	0	9223H207
14 14 10	0	9223H208
9 10 7	0	9223H209
16 14 22	0	9223H210
12 18 10	0	9223H211
14 12 9	0	9223H212
45 10 17	0	
28 16 19	0	9223H213
40		

Depth (ft) | Samples | Symbols



Materials Description

REDDISH BROWN GRAVELLY LEAN CLAY WITH SAND (CL) 5YR4/3, stiff, dry, 50% chert derived clay, 30% chert gravel, 20% fine-grained sand, fill

DARK OLIVE GRAY SILTY GRAVEL WITH SAND (GM) 5Y3/2, medium dense, moist, 60% serpentinite gravel, 20% silt, 20% fine-grained sand, fill

DARK OLIVE GRAY CLAYEY GRAVEL (GC) 5Y3/2, medium dense, moist, 50% serpentinite gravel, 10% chert gravel, 30% clay, 10% sand, fill

DARK OLIVE GRAY CLAYEY SAND WITH GRAVEL (SC) 5Y3/2 40% fine- to medium-grained serpentinite sand, 30% subangular serpentinite gravel, 20% clay, 10% silt, fill

VERY DARK GRAY GRAVELLY LEAN CLAY (CL) 5Y3/1, medium stiff, moist, 70% clay, 30% serpentinite gravel, fill

GRAYISH GREEN SERPENTINITE BOULDER FILL 5G5/2, moist, closely to moderately fractured, fresh

Very dark gray clay lenses up to 3 inches thick at 15 ft.

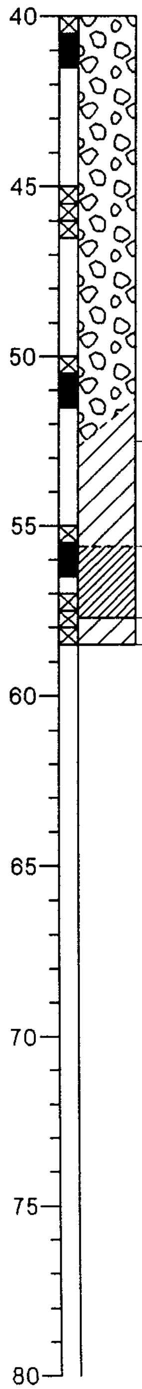
DARK GRAY GRAVELLY LEAN CLAY (CL) 5Y4/1, medium stiff, moist, 60-80% clay, 20-40% serpentinite gravel, fill

Sampler refusal at 35 ft., only able to drive sampler 1 inch

VERY DARK GRAY SERPENTINITE BOULDER FILL N3/0, wet, closely to occasionally fractured, contains dark gray clay lenses up to 2 inches thick

Project Number	
Project Name	Naval Station, Treasure Island
Project Task	Hunters Point Annex
Project Location	San Francisco, California
Equipment	DRILL SYSTEMS 1000 (ACH) 10 in. diam.
Date Drilled	06/03/1992
GS Elevation	8.42
Water Level	16.2 ft.
Total Depth Of Hole	58.5 ft.
Figure	

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)
24 17	0	9223H214	40
31 22 23	0		45
20 25 32	0	9223H215	50
17 16 18	28	9223H216	55
7 16 20	8		



Materials Description

Color change to dark bluish gray (5B4/1), some moderate weathering to silt and clay

VERY DARK GRAY GRAVELLY LEAN CLAY (CL) 5Y3/1, stiff, moist, 70% clay, 30% serpentinite gravel, fill

DARK GREENISH GRAY FAT CLAY (CH) 5GY4/1, medium stiff, moist, 70% clay, 30% shell fragments, Bay Mud Deposits

LIGHT OLIVE BROWN LEAN CLAY WITH SAND (CL) 2.5Y5/4, very stiff, dry to moist, 80% clay, 20% very f to fine-grained sand, few mottled gray nodules, few reddish brown staining, Undifferentiated Sedimentary Deposits

Bottom of boring at 58.5 feet. Boring backfilled with bentonite cement grout (6/3/92).

Project Number ____
Project Name Naval Station, Treasure Island
Project Task Hunters Point Annex
Project Location San Francisco, California
Equipment DRILL SYSTEMS 1000 (ACH) 10 in. diam.

Date Drilled 06/03/1992
GS Elevation 8.42
Water Level 16.2 ft.
Total Depth Of Hole 58.5 ft.

Figure

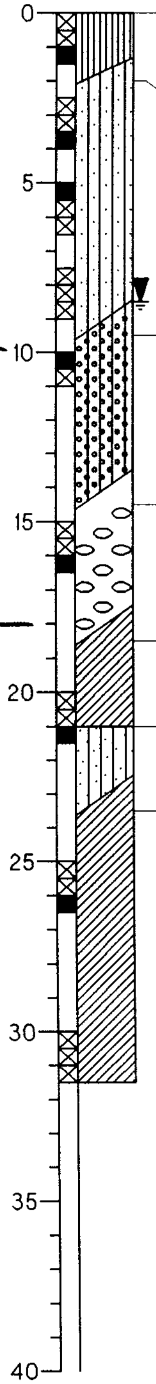
PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B216

Blows/6 in.	OVA (ppm)	Sample No.
4 18	0	9045P045
13 13 13	0	9045P046
12 14 15	0	9045P047
10 10 8	0	
10 50		9045P048
17 21 42	2	9045P050
1 1 2	0	9045P051
2 2 2	15	9045P052
1 1 1	10	

Depth (ft) Samples Symbols



Materials Description

DARK GRAYISH BROWN SANDY SILT WITH GRAVEL (MH) 10YR4/2, loose, dry, 50–60% silt, 20–25% medium- to coarse-grained sand, 15% gravel, fill

GRAYISH BROWN WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM), 10YR5/2, loose, dry, 70–75% medium- to coarse-grained sand, 20% angular gravel to 1 inch in diameter, 10–15% silt, fill

BLACK POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM) 10YR2/1, loose, wet, 35–40% coarse gravel, 10% fine gravel, 45% fine- to coarse-grained sand, 10–15% silt, oily, fill

BLACK WELL-GRADED GRAVEL WITH SILT AND SAND (GW-GM) 7.5YR2/0, dense, wet, fine gravel, very coarse-grained sand, oily, fill

DARK GRAY FAT CLAY (CH) 5Y4/1, very soft, wet

DARK GRAY TO BLACK SILTY SAND (SM) 5Y4/1 to 5Y2.5/1, very soft, wet, 80% fine-grained sand, 20% silt

DARK GRAY FAT CLAY (CH) 5Y4/1, very soft, moist, 95% clay, trace shell fragments, bay mud deposits

Bottom of boring at 31.5 feet. Boring backfilled with bentonite cement grout (11/9/90)

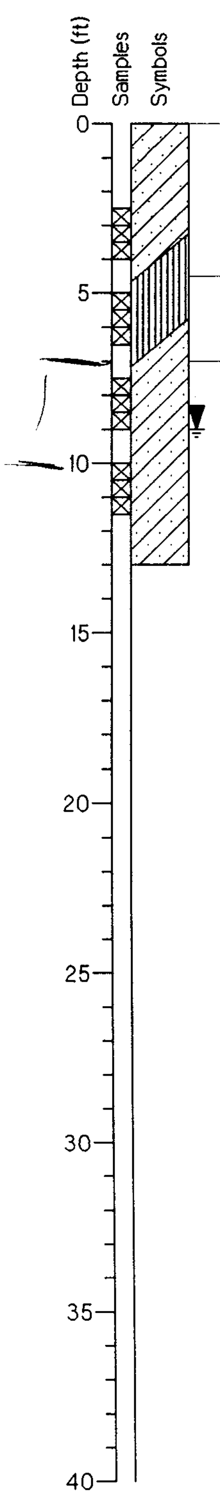
Project Number		Date Drilled	11/07/1990
Project Name	Naval Station, Treasure Island	GS Elevation	8.12
Project Task	Hunters Point Annex	Water Level	8.5 ft.
Project Location	San Francisco, California	Total Depth Of Hole	31.5 ft.
Equipment	CME 750 (HSA) 8 in. diam.	Figure	

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B216A

Blows/6 in.	OVA (ppm)	Sample No.
11		
12	0	
11		
1		
9	0	
7		
11		
10		
13		
14		
17		
50		



Materials Description

DARK BROWN CLAYEY SAND WITH GRAVEL (SC) 7.5YR4/2, loose, dry, 40-45% fine-grained sand, 30% angular gravel, 20% clay, fill

DARK BROWN GRAVELLY SILT WITH SAND (MH) 7.5YR3/2, loose, dry, 45-50% silt, 20-25% gravel, 10-20% clay, fill

BLACK WELL-GRADED SAND WITH CLAY AND GRAVEL (SW-SC) loose, moist, 50-60% fine-grained sand, 15-25% angular gravel, 10-15% clay, oily, fill

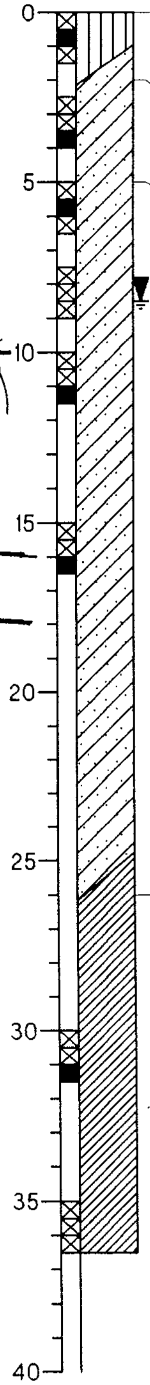
Drilling refusal at 13 ft. Boring backfilled with bentonite cement grout (11/9/90)

Project Number	
Project Name	Naval Station, Treasure Island
Project Task	Hunters Point Annex
Project Location	San Francisco, California
Equipment	CME 750 (HSA) 8.00 in. diam.
Date Drilled	11/07/1990
GS Elevation	~8.12
Water Level	9.00 ft.
Total Depth Of Hole	13.00 ft.
Figure	

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR03B217

Blows/6 in.	OVA (ppm)	Sample No.
19 50	4	9045P035A
15 27 19	20	9045P036A
8 10 14	80	9045P037A
7 9 6		
2 6 10	50	9045P038A
18 25 20		9045P039
1 2 2	50	9045P040
2 2 3		



Materials Description

BROWN TO GRAYISH BROWN SANDY SILT WITH GRAVEL (ML) 10YR5/3 to 10YR5/2, loose, dry, 50% silt, 30% sand, 20% greenstone gravel, fill

DARK GRAY CLAYEY SAND WITH GRAVEL (SC) 5Y4/1, loose to medium dense, moist, some wood debris, angular greenstone gravel to 1 inch in diameter, 20% clay, fill

Color change to very dark gray (5Y3/1)

No sample recovery from 7.5 to 9 ft.

Color change to black (2.5Y2/0), decreasing clay at 10 ft., oily

Color change to dark gray (5Y4/1), sheen

Heaving sands

DARK GRAY FAT CLAY (CH) 5Y4/1, very soft, wet, some shell fragments, bay mud deposits

Bottom of boring at 36.5 feet. Boring backfilled with bentonite cement grout (11/8/90)

Project Number		Date Drilled	11/07/1990
Project Name	Naval Station, Treasure Island	GS Elevation	6.43
Project Task	Hunters Point Annex	Water Level	8.5 ft.
Project Location	San Francisco, California	Total Depth Of Hole	36.5 ft.
Equipment	CME 750 (HSA) 8 in. diam.		

Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B218A

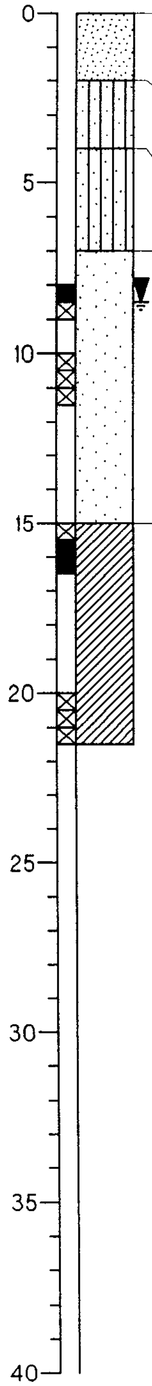
Blows/6 in.	(ppm)	Sample No.	Depth (ft)	Samples	Symbols	Materials Description
			0	☒		VERY DARK BROWN SILTY SAND (SM) 10YR2/2, very loose, moist, 70-80% fine to medium-grained sand, 20-30% silt, fill
						DARK REDDISH BROWN SANDY LEAN CLAY (CL) 5YR4/2, medium stiff, moist, 50-70% clay, 20-30% sand, 10% gravel, some wood debris and rocks
			5			Drilling refusal at 5.5 feet. Boring backfilled to surface with bentonite cement grout (date boring grouted not available)
			10			
			15			
			20			
			25			
			30			
			35			
			40			

Project Number	Date Drilled 10/31/1990	Figure
Project Name Naval Station, Treasure Island	GS Elevation ~7.67	
Project Task Hunters Point Annex	Water Level 0.00 ft.	
Project Location San Francisco, California	Total Depth Of Hole 5.00 ft.	
Equipment CME 55 (HSA) 8.00 in. diam.		

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR03B219

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)
18 50	>1000	9045P060	
4 8 12	>1000		10
2 2 1	240	9045P061	15
2 2 1			20



Materials Description

VERY DARK BROWN POORLY GRADED SAND (SP) 10YR3/2, medium dense, dry, 90% fine- to medium-grained sand, 5-10% silt, 0-5% gravel, fill

VERY DARK BROWN POORLY GRADED SAND WITH SILT (SP-SM) 10YR3/2, medium dense, dry, 80-85% sand, 15% silt, 0-5% gravel, some wood fragments, fill

DARK GREENISH GRAY SILTY SAND (SM) 5G4/1, dense, moist, 60-70% sand, 20-25% silt, 10-15% gravel, fill

BLACK WELL-GRADED SAND (SW) 10YR2/1, dense, saturated with product, 90% fine- to coarse- grained sand, 5-10% silt, 0-5% gravel, fill

DARK OLIVE GRAY FAT CLAY (CH) 5Y3/2, soft, wet, 75% clay, 25% shell fragments, bay mud deposits

Decreasing shell fragments at 20 ft.

Bottom of boring at 21.5 feet. Boring backfilled with bentonite cement grout (11/9/90)

Project Number
Project Name Naval Station, Treasure Island
Project Task Hunters Point Annex
Project Location San Francisco, California
Equipment CME 750 (HSA) 8 in. diam.

Date Drilled 11/08/1990
GS Elevation 7.41
Water Level 8.5 ft.
Total Depth Of Hole 21.5 ft.

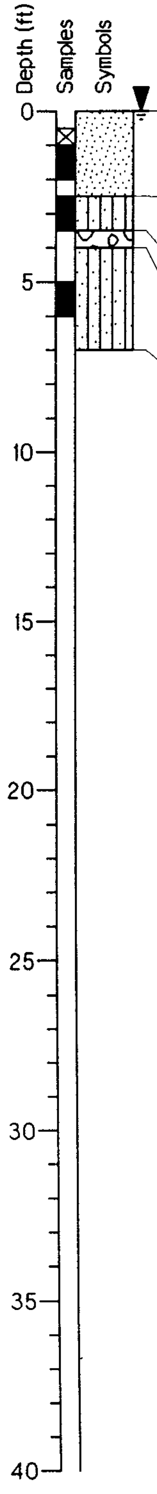
Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B219A

Blows/6 in.	(ppm)	Sample No.	Depth (ft)
4			
40		9045P054	
31			
22		9045P055	
50			
22		9045P056	5
50			



Materials Description

VERY DARK BROWN POORLY GRADED SAND (SP) 10YR3/2, medium dense, dry, 90% fine to medium-grained sand, 5-10% silt, 0-5% gravel, fill

VERY DARK BROWN SILTY SAND (SM) 10YR3/2, dense, dry, 80% sand, 15-20% silt, 0-5% gravel

GREENISH GRAY SERPENTINITE BOULDER FILL 5G6/1

DARK GREENISH GRAY SILTY SAND (SM) 5G4/1, dense, moist, 60-70% sand, 10-25% silt, 10-15% gravel

Drilling refusal at 7 ft. Boring backfilled with bentonite cement grout (11/9/90)

Project Number	Date Drilled 11/08/1990
Project Name Naval Station, Treasure Island	GS Elevation ~7.41
Project Task Hunters Point Annex	Water Level 0.00 ft.
Project Location San Francisco, California	Total Depth Of Hole 7.00 ft.
Equipment CME 750 (HSA) 8.00 in. diam.	

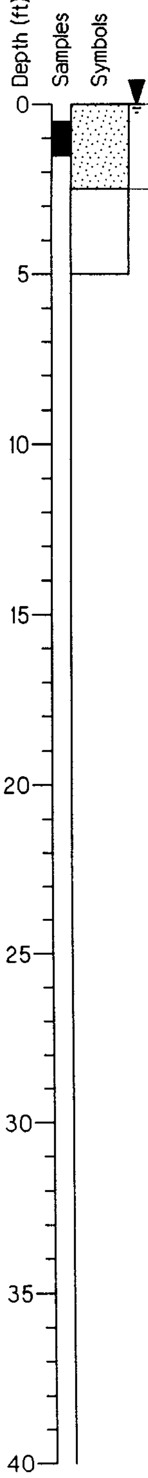
Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B219B

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)	Materials Description
15 22	0	9045P057	0	VERY DARK BROWN POORLY GRADED SAND (SP) 10YR3/2, medium dense, dry, 90% sand, 5-10% silt, fill
				DEBRIS FILL abundand wood and other debris
			5	Drilling refusal at 5 ft. Boring backfilled with bentonite cement grout (11/9/90)



Project Number ______
Project Name Naval Station, Treasure Island
Project Task Hunters Point Annex
Project Location San Francisco, California
Equipment CME 750 (HSA) 8.00 in. diam.

Date Drilled 11/08/1990
GS Elevation ~7.41
Water Level 0.00 ft.
Total Depth Of Hole 5.00 ft.

Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B219C

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)	Materials Description
12 15	0	9045P058	0	VERY DARK BROWN POORLY GRADED SAND (SP) 10YR3/2, medium dense, dry, 90% fine to medium-grained sand, 5-10% silt, 0-5% gravel, fill
22 49 50		9045P059		WEAK RED WELL-GRADED SAND WITH SILT (SW-SM) 10R5/2, dense, 80-85% medium-grained sand, 10% silt, 0-5% gravel, fill
12 50			5	BROWNISH YELLOW WELL-GRADED SAND (SW) 10YR6/8, medium dense, dry, 90% sand, 0-5% silt, 0-5% gravel, fill
				GREENISH GRAY SERPENTINITE BOULDER FILL 5G6/1
				Drilling refusal at 6.5 ft. Boring backfilled with bentonite cement grout (11/9/90)

Depth (ft): 0, 5, 10, 15, 20, 25, 30, 35, 40

Samples · Symbols

- Project Number
- Project Name: Naval Station, Treasure Island
- Project Task: Hunters Point Annex
- Project Location: San Francisco, California
- Equipment: CME 750 (HSA) 8.00 in. diam.
- Date Drilled: 11/08/1990
- GS Elevation: ~7.41
- Water Level: 0.00 ft.
- Total Depth Of Hole: 6.50 ft.

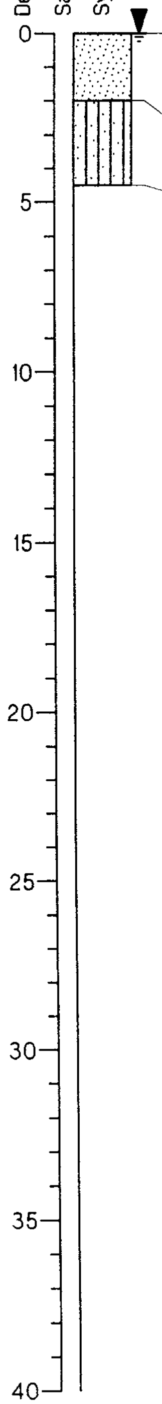
Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B219D

Blows/6 in.	(ppm)	Sample No.	Depth (ft)	Samples	Symbols	Materials Description



VERY DARK BROWN POORLY GRADED SAND (SP) 10YR3/2, medium dense, dry, 90–95% fine to medium-grained sand, 5–10% silt, 0–5% fine gravel, fill

VERY DARK BROWN SILTY SAND (SM) 10YR3/2, dense, dry, 80% sand, 15–20% silt, 0–5% gravel

Drilling refusal at 4.5 ft. Boring backfilled with bentonite cement grout (11/9/90)

Project Number ______

Project Name Naval Station, Treasure Island

Project Task Hunters Point Annex

Project Location San Francisco, California

Equipment CME 750 (HSA) 8.00 in. diam.

Date Drilled 11/08/1990

GS Elevation ~7.41

Water Level 0.00 ft.

Total Depth Of Hole 4.50 ft.

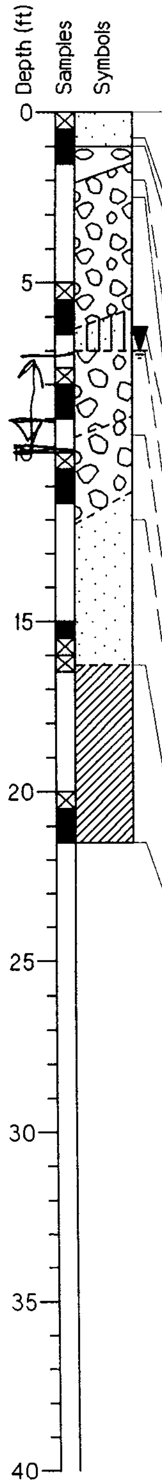
Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B220

Blows/6 in.	OVA (ppm)	Sample No.
33 38	4	9150G653
11 9 38	8	9150G654
6 6 6	10	9150G655
8 8 10	1	9150G656
9 5 3	4	9150G657
1 2 2	30	9150G658



Materials Description

BROWNISH YELLOW WELL-GRADED SAND (SW) 10YR6/6, loose, dry, 95% very fine- to course-grained sand, trace silt, fill (possible sandblast material)

Product staining from 0.75 to 1 ft.

YELLOWISH BROWN SILTY GRAVEL WITH SAND (GM) 10YR5/6, medium dense, moist, 50-55% fine to coarse serpentinite gravel, 15-20% silt, 15-20% sand, 5-10% clay, fill

DARK BLUISH GRAY SERPENTINITE BOULDER FILL 5B4/1, dense, moist, 100% serpentinite, some calcite veins

Boulder at 2.5 ft.

REDDISH BROWN SILTY SAND WITH GRAVEL (SM) 5YR4/4, medium dense, moist, 40-45% sand, 25-35% fine to coarse gravel, 15-20% silt, 10-15% clay, fill

DARK GREENISH GRAY WELL-GRADED GRAVEL (GW) 5BG4/1, dense, wet, 100% fine to coarse angular greenstone gravel, sheen on gravel, fill

DARK GREENISH GRAY WELL-GRADED GRAVEL WITH SAND (GW) 5BG4/1, dense, wet, 75-80% fine to coarse angular greenstone gravel, 15% sand, trace silt, fill

BLACK WELL-GRADED SAND (SW) 5Y2.5/1, loose to medium dense, wet, 80-85% fine- to coarse-grained sand, 5-10% fine gravel, 5% silt, sheen on sampler, Undifferentiated Upper Sand Deposits

DARK GREENISH GRAY FAT CLAY (CH) 5BG4/1, soft, moist, 70-75% clay, 15-20% silt, trace shell fragments and fiberous peat material, Bay Mud Deposits

Bottom of boring at 21.5 feet. Boring backfilled with bentonite cement grout (12/13/91).

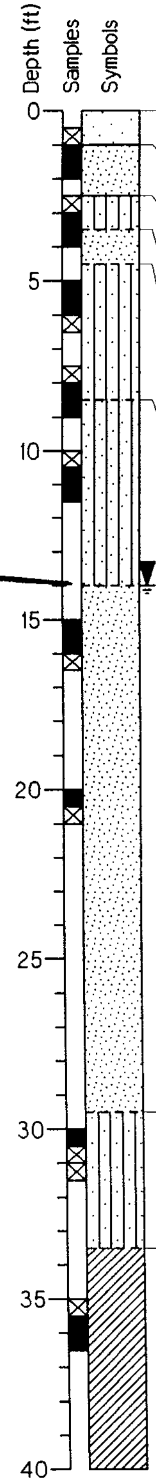
Project Number		Date Drilled	12/13/1991
Project Name	Naval Station, Treasure Island	GS Elevation	6.59
Project Task	Hunters Point Annex	Water Level	7.0 ft.
Project Location	San Francisco, California	Total Depth Of Hole	21.5 ft.
Equipment	CME 55 (HSA) 8 in. diam.		

Figure

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR03B221

Blows/6 in.	OVA (ppm)	Sample No.
2, 6, 4	0	9045P066
5, 18, 12	350	9045P067
8, 12, 18	250	9045P068
10, 9, 7	15	9045P069
2, 14, 14	60	9045P070
17, 15, 12	250	9045P071
23, 50	55	9045P072
1, 2, 2	0	9045P075
1, 2, 3	15	9045P076
2		



Materials Description

OLIVE BROWN WELL-GRADED SAND (SW) 2.5Y4/4, loose, dry, 80-90% sand, 0-5% silt, 5-10% gravel, fill

WHITE POORLY GRADED SAND (SP) 2.5Y8/2, loose, dry, 95% fine- to medium-grained sand, 5% silt, fill

DARK OLIVE GRAY WELL-GRADED SAND WITH SILT (SW-SM) 5Y3/2, dense, wet, 80% fine- to medium-grained sand, 10% silt, 10% medium to coarse gravel, fill

WHITE POORLY GRADED SAND (SP) 2.5Y8/2, loose, moist, 90% fine- to medium-grained sand, 5% silt, 5% gravel, fill

BLACK WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM) 5Y2.5/2, dense, dry, 60-70% fine- to medium-grained sand, 10% silt, 20-30% medium gravel, fill

DARK OLIVE GRAY SILTY SAND WITH GRAVEL (SM) 5Y3/2, medium dense, moist, 50-60% sand, 25-30% silt, 15-20% gravel, fill

OLIVE GRAY POORLY GRADED SAND (SP) 5Y4/2, medium dense, wet, 80-90% medium-grained sand, 5-15% gravel, 5% silt, 0-5% wood fragment (saturated with product)

OLIVE GRAY POORLY GRADED SAND WITH SILT (SP-SM) 5Y5/2, loose, wet, 90% fine-grained sand, 10% silt

DARK OLIVE GRAY FAT CLAY (CH) 5Y3/2, soft to medium stiff, moist, 95% clay, 0-5% shell fragments, bay mud deposits

Project Number	
Project Name	Naval Station, Treasure Island
Project Task	Hunters Point Annex
Project Location	San Francisco, California
Equipment	CME 750 (HSA) 8 in. diam.
Date Drilled	11/09/1990
GS Elevation	7.30
Water Level	14 ft.
Total Depth Of Hole	41.5 ft.
Figure	

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)	Materials Description
2			40	
1				Bottom of boring at 41.5 feet. Boring backfilled with bentonite cement grout (11/9/90)
			45	
			50	
			55	
			60	
			65	
			70	
			75	
			80	

Project Number
Project Name Naval Station, Treasure Island
Project Task Hunters Point Annex
Project Location San Francisco, California
Equipment CME 750 (HSA) 8 in. diam.

Date Drilled 11/09/1990
GS Elevation 7.30
Water Level 14 ft.
Total Depth Of Hole 41.5 ft.

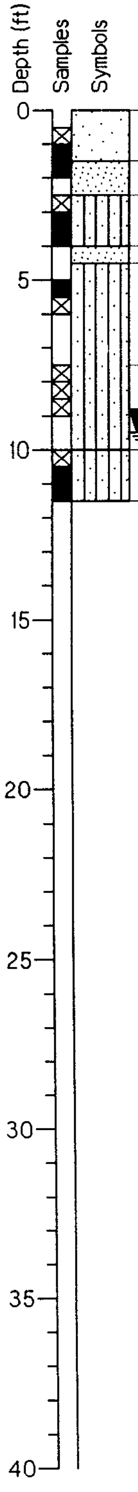
Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B221A

Blows/6 in.	OVA (ppm)	Sample No.
1		
4	0	9045P062
14		
8		
12	0	9045P063
14		
12	35	9045P064
50		
15		
9		
12		
4		
7	350	9045P065
7		



Materials Description

OLIVE BROWN WELL-GRADED SAND (SW) 2.5Y4/4, loose, dry, 80-90% sand, 0-5% silt, 5-10% gravel

WHITE POORLY GRADED SAND (SP) 2.5Y8/2, loose, dry, 95% fine to medium-grained sand, 5% silt, fill

DARK OLIVE GRAY WELL-GRADED SAND WITH SILT (SW-SM) 5Y3/2, medium dense, moist, 80% fine to medium-grained sand, 10% silt, 10% gravel, fill

WHITE POORLY GRADED SAND (SP) 2.5Y8/2, loose to medium dense, moist, 95% fine to medium-grained sand, 5% silt, fill

DARK OLIVE GRAY WELL-GRADED SAND WITH SILT (SW-SM) 5Y3/2, medium dense, moist, 75-80% sand, 10% silt, 10-15% gravel

No sample recovery from 7.5 to 9 ft.

DARK OLIVE GRAY WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM), 5Y3/2, wet, 50-60% fine to medium-grained sand, 10% silt, 30-40% angular gravel, saturated with product

Drilling refusal at 11.5 ft. Boring backfilled with bentonite cement grout (11/12/90)

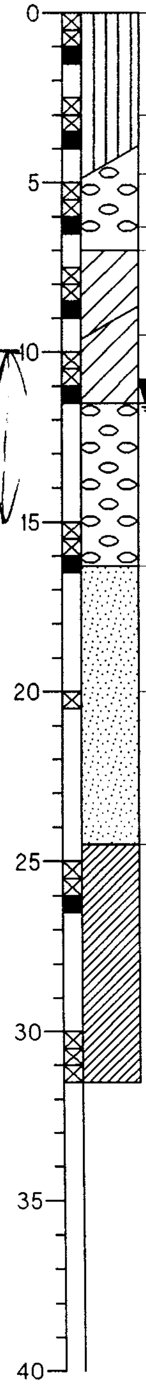
Project Number		Date Drilled	11/09/1990
Project Name	Naval Station, Treasure Island	GS Elevation	~7.30
Project Task	Hunters Point Annex	Water Level	9.50 ft.
Project Location	San Francisco, California	Total Depth Of Hole	11.50 ft.
Equipment	CME 750 (HSA) 8.00 in. diam.		

Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

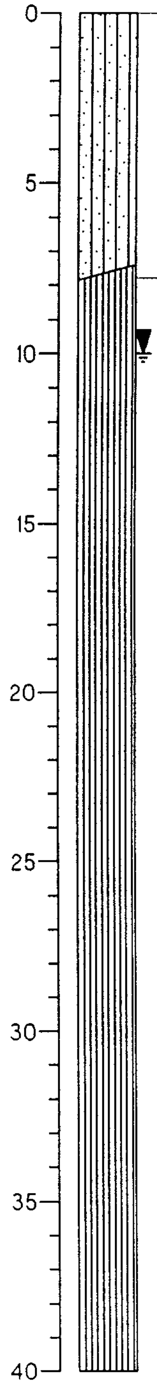
LOG OF BORING IR03B223



Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)	Materials Description
6, 19	0	9046H391	0	VERY DARK GRAYISH BROWN SILT WITH SAND (ML) 10YR3/1, very loose, dry, 70-80% silt, 10-20% fine- to medium-grained sand, 10% well-graded gravel, carbon material, fill
5, 6, 18	0	9046H392		Increasing gravel to 25% at 3 ft.
20, 25, 40	30	9046H393	5	VERY DARK GRAYISH BROWN SILTY GRAVEL WITH SAND (GM) 10YR3/2, loose to medium dense, dry, 50-60% well-graded gravel, 20-30% silt, 20-30% fine- to medium-grained sand, fill
20, 26, 21	94	9046H394		Asphalt coating at 6.3 ft.
				DARK OLIVE GRAY GRAVELLY LEAN CLAY WITH SAND (CL) 5Y3/2, medium stiff, moist, 50-60% clay, 20-30% well-graded gravel, 10-20% fine- to medium-grained sand, trace wood debris, fill
1, 18, 23	120	9046H395	10	DARK OLIVE BROWN SANDY LEAN CLAY (CL) 5Y3/2, medium stiff, moist to wet, 50-60% clay, 20-30% fine- to medium-grained sand, 10-20% well-graded gravel, wood debris and product staining, fill
14, 17, 27	250	9046H396	15	BLACK WELL-GRADED GRAVEL WITH SILT AND SAND (GW-GM) loose, wet, saturated with oil, 60-80% gravel, 10-30% medium- to coarse-grained sand, 10-20% wood debris, nails and glass, 0-10% silt, fill
				BLACK POORLY GRADED SAND (SP) 5Y2.5/2, loose, 95-100% fine- to medium-grained sand, 0-5% silt, 5- shell fragments
50			20	Gravel zone from 20 to 22 ft.
				Heaving sands
4, 3, 4	5	9046H397	25	DARK GREENISH GRAY FAT CLAY (CH) 5GY4/1, medium stiff, 95-100% clay, 0-5% silt, few shell fragments, bay mud deposits
2, 3, 2			30	Bottom of boring at 31.5 feet. Boring backfilled with bentonite cement grout (11/12/90)

Project Number	
Project Name	Naval Station, Treasure Island
Project Task	Hunters Point Annex
Project Location	San Francisco, California
Equipment	CME 750 (HSA) 8 in. diam.
Date Drilled	11/12/1990
GS Elevation	9.26
Water Level	11.5 ft.
Total Depth Of Hole	31.5 ft.
Figure	

Blows/6 in.	(ppm)	Sample No.	Depth (ft)	Samples	Symbols	Materials Description



DARK GRAYISH BROWN SILTY SAND (SM) 2.5Y4/2, loose, moist, very fine- to coarse-grained sand, with 15% silt, fill

Trace subangular gravel to 0.5 inches in diameter at 4 ft.

Color change to dark gray (5Y4/1) at 6 ft., medium-grained sand, 40% silt

DARK GRAY SILT WITH SAND (MH) 5Y4/1, soft, moist, 10% fine sand, trace shell fragments, Bay Mud Deposits

Wet at 10 ft., 25% shell fragments

Begin 94mm continuous coring at 14 ft.

30-40% shell fragments up to 0.75 inches in diameter at 24 ft.

10% shell fragments at 30 ft.

25-30% shell fragments at 35 ft.

Project Number

Project Name Naval Station, Treasure Island

Project Task Hunters Point Annex

Project Location San Francisco, California

Equipment FAILING 1500 (MDR) 5 in. diam.

Date Drilled 01/30/1989

GS Elevation 7.64

Water Level 10.00 ft.

Total Depth Of Hole 162 ft.

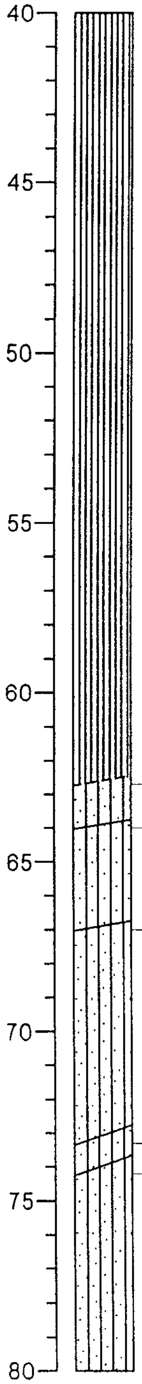
Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B227

Blows/6 in.	(ppm)	Sample No.	Depth (ft)	Samples	Symbols	Materials Description



Trace shell fragments at 51 ft.

20-30% shell fragments at 56 ft.

LIGHT YELLOWISH BROWN SILTY SAND (SM) 2.5Y6/4, medium dense, wet, with 20% silt Undifferentiad Sedimentary Deposits

YELLOWISH BROWN POORLY GRADED SAND WITH SILT (SP-SM) 10YR5/4, loose, wet, 10% silt, Undifferentiated Sedimentary Deposits

LIGHT YELLOWISH BROWN SILTY SAND (SM) 10YR6/4, very dense, slightly moist, with 40% silt and trace iron oxide mottling Undifferentiated Sedimentary Deposits

GRAYISH BROWN POORLY GRADED SAND WITH SILT (SP-SM) 2.5Y5/2, loose, wet, medium-grained sand with 10% silt

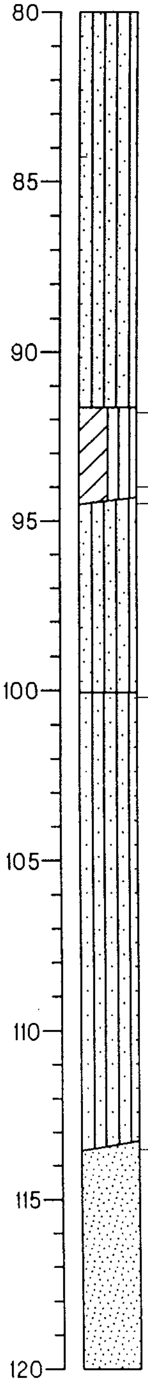
LIGHT YELLOWISH BROWN SILTY SAND (SM) 10YR6/4, dense, wet, fine to medium-grained sand, 25% silt, 25% shell fragments and occasional subangular gravel to .5 inches in diameter

Project Number	Date Drilled 01/30/1989	Figure
Project Name Naval Station, Treasure Island	GS Elevation 7.64	
Project Task Hunters Point Annex	Water Level 10.00 ft.	
Project Location San Francisco, California	Total Depth Of Hole 162 ft.	
Equipment FAILING 1500 (MDR) 5 in. diam.		

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR03B227

Blows/6 in.	(ppm)	Sample No.	Depth (ft)	Samples	Symbols	Materials Description



Color change to dark gray (5Y4/1) at 86 ft.

Color change to very dark gray (5Y3/1), 10% shell fragments, medium to fine-grained sand, 20% silt at 89 ft.

DARK GRAY SILTY CLAY WITH SAND (CL/ML) 5Y4/1, stiff, moist, 30-40% silt, 15% very fine-grained sand, trace shell fragments

Very stiff at 94 ft.

DARK GRAY SILTY SAND (SM) 5Y4/1, very dense, 40% silt

YELLOWISH BROWN POORLY GRADED SAND WITH SILT (SP-SM) 10YR5/6, medium dense, wet, with 5-10% silt, Undifferentiated Sedimentary Deposits

Color change to olive (5Y5/3) at 112 ft.

DARK GRAYISH BROWN POORLY GRADED SAND (SP) 2.5Y4/2, very dense, wet

Project Number		Date Drilled	01/30/1989
Project Name	Naval Station, Treasure Island	GS Elevation	7.64
Project Task	Hunters Point Annex	Water Level	10.00 ft.
Project Location	San Francisco, California	Total Depth Of Hole	162 ft.
Equipment	FAILING 1500 (MDR) 5 in. diam.		

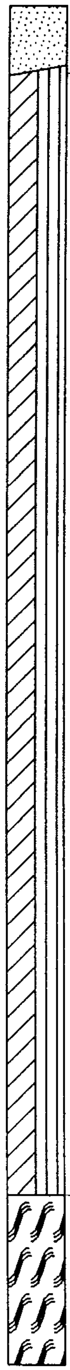
Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B227

Blows/6 in.	(ppm)	Sample No.	Depth (ft)	Samples	Symbols	Materials Description
			120			
						DARK GRAY SILTY CLAY (CL/ML) 5Y4/1, very stiff, wet, with 10% very fine-grained sand
			125			
			130			
			135			Occasional subangular gravel to 0.5 inches in diameter
			140			Sand content increasing to 30-35%, with 5% gravel to inches in diameter at 140 ft.
			145			Gravel content increasing to 5-10% at 145 ft.
			150			
			155			LIGHT GRAYISH GREEN SERPENTINITE BEDROCK hard, moderately weathered
						(poor core recovery; likely due to intense fracturing and clay in fractures)
			160			Becoming slightly weathered at 155 ft. (drill cuttings logged from 155 to 162 ft.)



Project Number	
Project Name	Naval Station, Treasure Island
Project Task	Hunters Point Annex
Project Location	San Francisco, California
Equipment	FAILING 1500 (MDR) 5 in. diam.
Date Drilled	01/30/1989
GS Elevation	7.64
Water Level	10.00 ft.
Total Depth Of Hole	162 ft.
Figure	

Blows/6 in.	(ppm)	Sample No.	Depth (ft)	Samples	Symbols	Materials Description
			160			
						Bottom of boring at 162 feet. Boring geophysically logged and backfilled with bentonite cement grout.
			165			
			170			
			175			
			180			
			185			
			190			
			195			
			200			

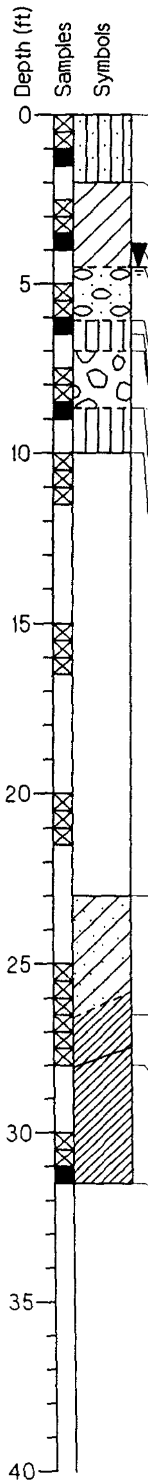
Project Number ______
Project Name Naval Station, Treasure Island
Project Task Hunters Point Annex
Project Location San Francisco, California
Equipment FAILING 1500 (MDR) 5 in. diam.

Date Drilled 01/30/1989
GS Elevation 7.64
Water Level 10.00 ft.
Total Depth Of Hole 162 ft.

Figure

LOG OF BORING IR03B228A

Blows/6 in.	OVA (ppm)	Sample No.
	0	9114H682
	0	9114H683
	40	9114H684
	60	9114H685
	80	9114H686



Materials Description

VERY DARK GRAYISH BROWN WELL-GRADED SAND WITH SILT (SW-SM) 10YR3/2, loose to medium dense, dry, 90-95% fine- to coarse-grained sand, 5-10% silt, fill

DARK GRAY LEAN CLAY WITH SAND (CL) 5Y4/1, medium stiff, moist, 80-90% clay, 10-20% well-graded fine- to coarse-grained sand, fill

Trace to 10% well-graded gravel at 4 ft.

BLACK CLAYEY GRAVEL WITH SAND (GC) 2.5Y2/0, loose to medium dense, wet, 50-80% well-graded subangular to subrounded gravel, 10-30% poorly graded coarse- to very coarse-grained sand, 10-20% lean clay, saturated with product, fill

BLACK SANDY SILT WITH GRAVEL (ML) medium stiff, moist, 50% silt, 20-30% fine- to medium-grained sand, 20-30% poorly graded subangular chert gravel, fill

Product stained wood debris at 6.5 ft.

VERY DARK GRAY WELL-GRADED GRAVEL (GW) loose, wet, 95% angular to subangular chert and other gravel, 5% fine- to medium-grained sand, trace product staining, fill

VERY DARK GRAY SANDY SILT WITH GRAVEL (ML) 7.5YR3/0, soft to medium stiff, moist, 60% silt, 40% fine- to medium-grained sand, trace fine gravel, little to some wood debris (appears burned), trace metal debris and produc'

DEBRIS ZONE wire, metal and concrete rubble, no samp. recovery

DARK GREENISH GRAY CLAYEY SAND (SC) 5GY4/1, soft, loose, 60% poorly graded fine-grained sand, 40% clay, undifferentiated upper sand deposits

DARK GREENISH GRAY SANDY FAT CLAY (CH) 5G4/1, medium stiff, moist, 60-70% clay, 30-40% fine-grained sand, bay mud deposits

DARK GREENISH GRAY FAT CLAY (CH) 5G4/1, medium stiff, moist, 95% clay, 5% silt, few to some shell fragments, bay mud deposits

Bottom of boring at 31.5 feet. Opened hole to 15 in. from 0 to 16.2 feet. Refusal at 16.2 feet. Boring backfilled with bentonite cement grout (4/4/91)

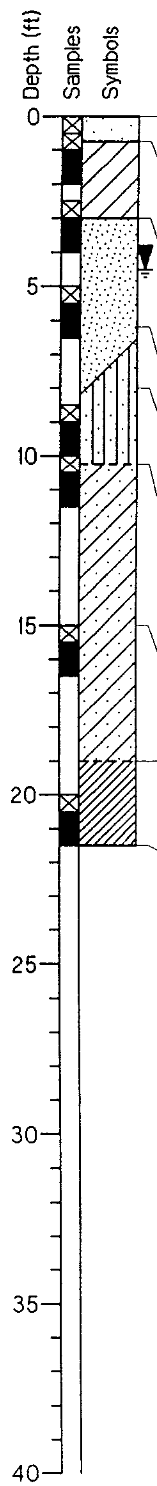
Project Number		Date Drilled	04/03/1991
Project Name	Naval Station, Treasure Island	GS Elevation	8.01
Project Task	Hunters Point Annex	Water Level	4.5 ft.
Project Location	San Francisco, California	Total Depth Of Hole	31.5 ft.
Equipment	CF-15 (MDR) 6.75 in. diam.		

Figure

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR03B337

Blows/6 in.	OVA (ppm)	Sample No.
17 12 11	0	9223H239
9 9 8	0	9223H240
6 6 6		9223H241
4 3 3		9223H242
5 3 3		9223H243
3 1 1	1	9223H244
2 1 1	30	9223H245



Materials Description

LIGHT YELLOWISH BROWN WELL-GRADED SAND (SW) 2.5Y6/4, loose, dry, 85% very fine- to coarse-grained sand, 10% fine gravel, 5% silt, fill

VERY DARK GRAYISH BROWN GRAVELLY LEAN CLAY (CL) 2.5Y3/2, stiff, dry, 60% clay, 30% serpentinite gravel, 10% fine-grained sand, fill

VERY DARK GRAYISH BROWN POORLY GRADED SAND (SP) loose, moist, 65% shell fragments, 15% coarse-grained sand, 10% fine gravel, 10% wood and organic debris, fill (Dredge Material?)

Color change to black (N2/0), no shell fragments, 85% coarse-grained sand, 15% fine gravel

DARK GREENISH GRAY POORLY GRADED SAND WITH SILT (SP-SM) 5G4/1, loose, wet, 60% shell fragments, 20% fine-grained sand, 10% silt, 10% fine gravel, Undifferentiated Upper Sand Deposits

DARK GREENISH GRAY POORLY GRADED SAND WITH CLAY (SP-SC) 5G4/1, loose, wet, 75% fine-grained sand, 15% shell fragments, 10% clay, Undifferentiated Upper Sand Deposits

Color change to olive gray (5Y4/2) at 15 ft., decreasing shell fragments to 5%

DARK GREENISH GRAY FAT CLAY (CH) 5GY4/1, medium stiff, moist, 85% clay, 10% shell fragments, 5% silt, Bay Mud Deposits

Bottom of boring at 21.5 feet. Boring backfilled with bentonite cement grout (6/5/92).

Project Number		Date Drilled	06/05/1992
Project Name	Naval Station, Treasure Island	GS Elevation	5.59
Project Task	Hunters Point Annex	Water Level	4.5 ft.
Project Location	San Francisco, California	Total Depth Of Hole	21.5 ft.
Equipment	DRILL SYSTEMS 1000 (ACH) 10 in. diam.		

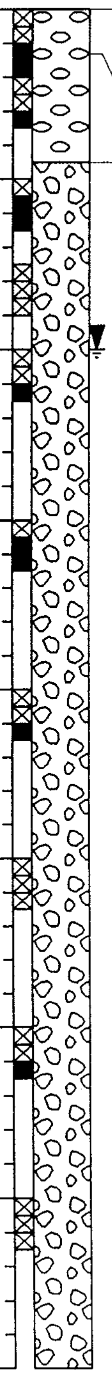
Figure

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B338

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)	Materials Description
31 24 20	0	9226N031	0	LIGHT BROWNISH GRAY SILTY GRAVEL WITH SAND (GM) 2.5Y6/2, loose, dry, 50% coarse gravel, 25% silt, 25% sand, fill
8 10 14	0	9226N032		Color change to dark grayish brown (2.5Y4/2) at 1.3 ft., moist with trace metal debris
16 20 27	0	9226N033	5	DARK GREENISH GRAY SERPENTINITE BOULDER FILL 5GY4/1, moist, moderately to occasionally fractured, very hard
40 20 15	0			No recovery at 7.5 ft., serpentinite boulder fill logged from cuttings
9 9 9	0	9226N034	10	Wet at 10 ft., with strong product sheen
5 14 31	0	9226N035	15	Slight product sheen at 15 ft.
25 22 50	0	9226N036	20	Slight product sheen at 20 ft.
45 23 26	0		25	No recovery at 25 ft., no product sheen observed in cuttings, hard, slow drilling
21 20 41	0	9226N038	30	
22 31 36	0		35	Continue Serpentinite Boulder Fill with a 2 inch fine-grained brown sand lens at 35 ft.
35			40	



Project Number ____

Project Name: Naval Station, Treasure Island

Project Task: Hunters Point Annex

Project Location: San Francisco, California

Equipment: DRILL SYSTEMS 1000 (ACH) 10 in. diam.

Date Drilled: 06/22/1992

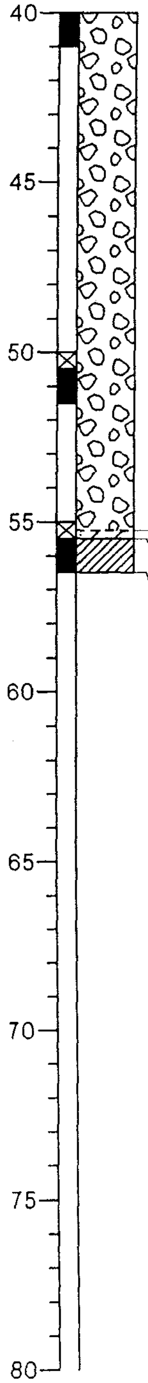
GS Elevation: 8.01

Water Level: 10.0 ft.

Total Depth Of Hole: 56.5 ft.

Figure

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)
50	0	9226N039	40
31 36 45	0	9226N040	50
29 30 19	0	9226N041	55



Materials Description

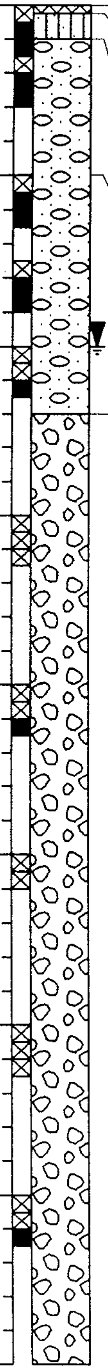
DARK GREENISH GRAY CLAYEY SAND (SC) 5GY4/1, medium dense, wet, 70% fine-grained sand, 30% fat clay, Undifferentiated Upper Sand Deposits

DARK GREENISH GRAY FAT CLAY (CH) 5G4/1, stiff, moist, 70% clay, 30% shell fragments, Bay Mud Deposits

Bottom of boring at 56.5 feet. Boring backfilled with bentonite cement grout (6/22/92). Grab water sample 9226N037 collected.

Project Number		Date Drilled	06/22/1992
Project Name	Naval Station, Treasure Island	GS Elevation	8.01
Project Task	Hunters Point Annex	Water Level	10.0 ft.
Project Location	San Francisco, California	Total Depth Of Hole	56.5 ft.
Equipment	DRILL SYSTEMS 1000 (ACH) 10 in. diam.	Figure	

LOG OF BORING IR03B339



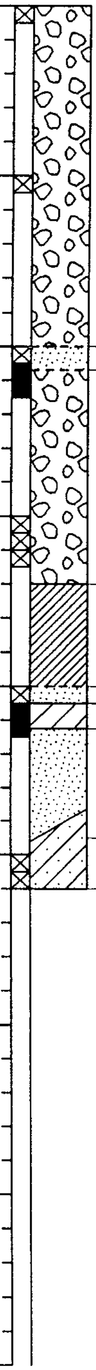
Depth (ft)	Blows/6 in.	OVA (ppm)	Sample No.	Materials Description
0	28 39	0	9226A321	ASPHALT
	13 18 17	0	9226A322	OLIVE BROWN SILTY SAND WITH GRAVEL (SM) 2.5Y4/3, medium dense, dry, 60% medium- to coarse-grained sand, 20% silt, 20% angular gravel, fill
				DARK GREENISH GRAY CLAYEY GRAVEL (GC) 5GY4/1, loose, dry, 60% angular serpentinite gravel, 40% lean clay, fill
5	8 12 8	0	9226A323	Increasing serpentinite gravel to 70%, decreasing lean clay to 30% at 5 ft.
	6 12 12	0	9226A324	
10	26 15 12	0	9226A325	Wet at 10 ft.
				DARK GREENISH GRAY SERPENTINITE BOULDER FILL 5GY4/1, wet, closely to occasionally fractured, weathered
15	35 25 15			No recovery at 15 feet. Serpentinite boulder fill logged from cuttings.
20	18 25 19	0	9226A326	15% clay at 20 ft.
25	16 50			No recovery at 25 and 30 feet. Serpentinite boulder fill logged from cuttings.
30	28 40 50			
35	33 33 29	0	9226A328	
40	50			

Project Number		Date Drilled	06/23/1992
Project Name	Naval Station, Treasure Island	GS Elevation	8.01
Project Task	Hunters Point Annex	Water Level	10.0 ft.
Project Location	San Francisco, California	Total Depth Of Hole	66.0 ft.
Equipment	DRILL SYSTEMS 1000 (ACH) 10 in. diam.	Figure	

PRC Environmental Management, Inc.
Adapted from Harding Lawson Associates

LOG OF BORING IR03B339

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)
			40
50			45
19 28 33	0	9226A329	50
49 16 23			55
14 28 50	30	9226A330	60
32 70			65
			70
			75
			80



Materials Description

Sampler refusal at 40 and 45 feet. Serpentinite boulder fill logged from cuttings.

DARK GRAY POORLY GRADED SAND WITH GRAVEL (SP) loose, wet, 80% medium-grained sand, 20% serpentinite gravel, fill

DARK GREENISH GRAY SERPENTINITE BOULDER FILL 5GY4/1, wet, moderately to occasionally fractured

DARK GREENISH GRAY FAT CLAY (CH) 5GY4/1, soft, wet, 70% clay, 20% shell fragments, 10% fine-grained sand, Bay Mud Deposits

Bay Mud logged from cuttings at 57 ft.

DARK GREENISH GRAY POORLY GRADED SAND (SP) 5G4/1, medium dense, wet, 100% fine-grained sand, Undifferentiated Sedimentary Deposits

LIGHT YELLOWISH BROWN LEAN CLAY (CL) 10YR6/4, medium stiff, moist, 90% clay, 10% fine-grained sand, Undifferentiated Sedimentary Deposits

YELLOWISH BROWN POORLY GRADED SAND (SP) 10YR5/6, dense, moist, 100% fine-grained sand, Undifferentiated Sedimentary Deposits

LIGHT YELLOWISH BROWN POORLY GRADED SAND WITH CLAY (SP-SC) 10YR6/4, dense, moist, 90% fine-grained sand, 10% lean clay, Undifferentiated Sedimentary Deposits

Bottom of boring at 66 feet. Boring backfilled with bentonite cement grout (6/23/92). Grab water sample 9226A327 collected.

Project Number		Date Drilled	06/23/1992
Project Name	Naval Station, Treasure Island	GS Elevation	8.01
Project Task	Hunters Point Annex	Water Level	10.0 ft.
Project Location	San Francisco, California	Total Depth Of Hole	66.0 ft.
Equipment	DRILL SYSTEMS 1000 (ACH) 10 in. diam.	Figure	

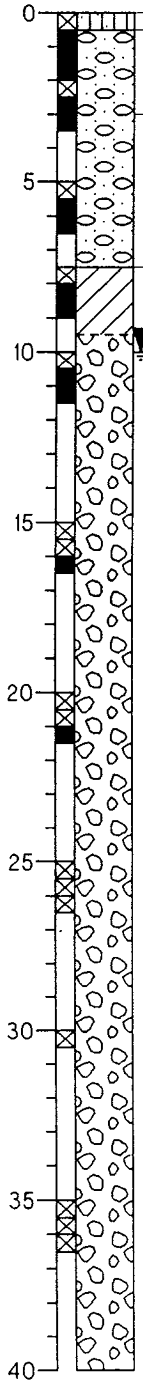
PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B340

Blows/6 in.	OVA (ppm)	Sample No.
21 30 37	0	9226A331
18 37 43	0	9226A332
18 22 31	0	9226A333
14 19 14	0	9226A334
10 11 11	0	9226A335
12 23 23		9226A336
16 14 18	0	9226A337
26 27 35		
50		
41 32 29	0	
39		

Depth (ft) Samples Symbols



Materials Description

YELLOWISH BROWN SILTY SAND WITH GRAVEL (SM) 10YR5/4, medium dense, dry, 45% medium- to coarse-grained sand, 30% silt, 25% subangular gravel, fill

DARK YELLOWISH BROWN CLAYEY GRAVEL (GC) 10YR4/4, medium stiff, dry, 70% angular chert gravel, 30% lean clay, fill

Color change to dark bluish gray (5B4/1). Serpentinite gravel with 45% clay at 3 ft.

DARK GRAY GRAVELLY LEAN CLAY WITH SAND (CL) 5Y4/1, soft, moist, 45% clay, 30% angular serpentinite gravel, 25% medium- to coarse-grained sand, fill

DARK BLUISH GRAY SERPENTINITE BOULDER FILL 5B4/1, medium dense, wet, 75% closely to occasionally fractured serpentinite, 25% lean clay

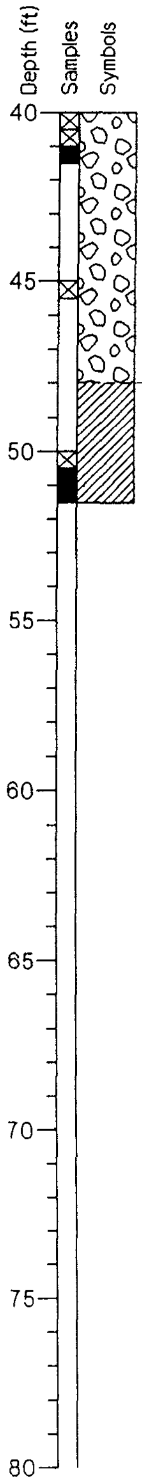
Decrease clay to trace by 20 ft.

No recovery at 25 and 30 ft.

Project Number		Date Drilled	06/23/1992
Project Name	Naval Station, Treasure Island	GS Elevation	8.35
Project Task	Hunters Point Annex	Water Level	10.0 ft.
Project Location	San Francisco, California	Total Depth Of Hole	51.5 ft.
Equipment	DRILL SYSTEMS 1000 (ACH) 10 in. diam.		

Figure

Blows/6 in.	OVA (ppm)	Sample No.	Depth (ft)	Materials Description
22 31	0	9226A339	40	
50			45	Sampler refusal at 45 ft.
				DARK GREENISH GRAY FAT CLAY (CH) 5GY4/1, soft, wet, 50% clay, 40% shell fragments, 10% fine-grained sand, Bay Mud Deposits
3 5 8	0	9226A340	50	Bottom of boring at 51.5 feet. Boring backfilled with bentonite cement grout (6/23/92). Grab water sample 9226A338 collected.



Project Number ______
Project Name Naval Station, Treasure Island
Project Task Hunters Point Annex
Project Location San Francisco, California
Equipment DRILL SYSTEMS 1000 (ACH) 10 in. diam.

Date Drilled 06/23/1992
GS Elevation 8.35
Water Level 10.0 ft.
Total Depth Of Hole 51.5 ft.

Figure

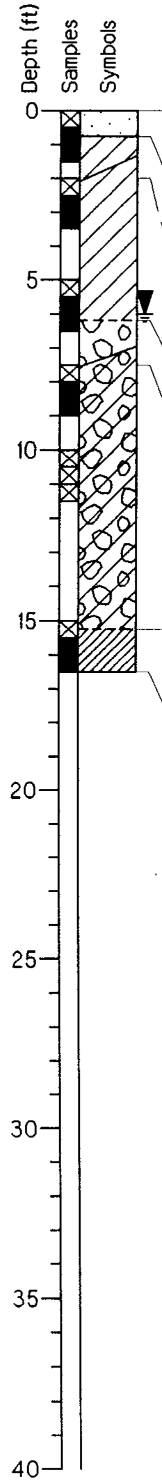
Continue

PRC Environmental Management, Inc.

Adapted from Harding Lawson Associates

LOG OF BORING IR03B341

Blows/6 in.	OVA (ppm)	Sample No.
10 12 16	0	9224H277
18 12	0	9224H278
15 14 10	1	9224H279
13 17 16	1	9224H280
1 4 3	0	
5 3 3		9224H281



Materials Description

BROWN WELL-GRADED SAND (SW) 10YR5/3, loose, dry, 95% fine- to very coarse-grained sand, 5% subrounded fine gravel, fill

VERY DARK GRAYISH BROWN GRAVELLY LEAN CLAY (CL) 2.5Y3/2, medium stiff, dry, 60% clay, 30% fine to medium subrounded gravel, 10% fine-grained sand, fill

VERY DARK GRAYISH BROWN GRAVELLY LEAN CLAY WITH SAND (CL) 50% clay, 30% gravel, 20% sand, trace shell fragments, fill

VERY DARK GRAY WELL-GRADED GRAVEL (GW) 5Y3/1, loose, wet, fine to coarse gravel

VERY DARK GRAY WELL-GRADED GRAVEL WITH CLAY (GW-GC) 5Y3/1, loose, wet, 90% fine to coarse subangular to subrounded serpentinite and chert gravel, 10% clay, fill

DARK GREENISH GRAY FAT CLAY (CH) 5GY4/1, medium stiff, moist, 80% clay, 15% shell fragments, 5% silt, Bay Mud Deposits

Bottom of boring at 16.5 feet. Boring backfilled with bentonite cement grout (6/10/92).

Project Number

Project Name Naval Station, Treasure Island

Project Task Hunters Point Annex

Project Location San Francisco, California

Equipment DRILL SYSTEMS 1000 (ACH) 10 in. diam.

Date Drilled 06/10/1992

GS Elevation 5.62

Water Level 6.0 ft.

Total Depth Of Hole 16.5 ft.

Figure